AUG 5 1937

CIVIL ENGINEERING

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MOVING A FALLEN GIANT—A STEP IN MANUFACTURING LUMBER
This "Stick," 600 Years Old and Over 6 Ft Across at the Small End, Was Thus Hauled 2,000 Ft

Volume 7 — *Number 8*

AUGUST 1937

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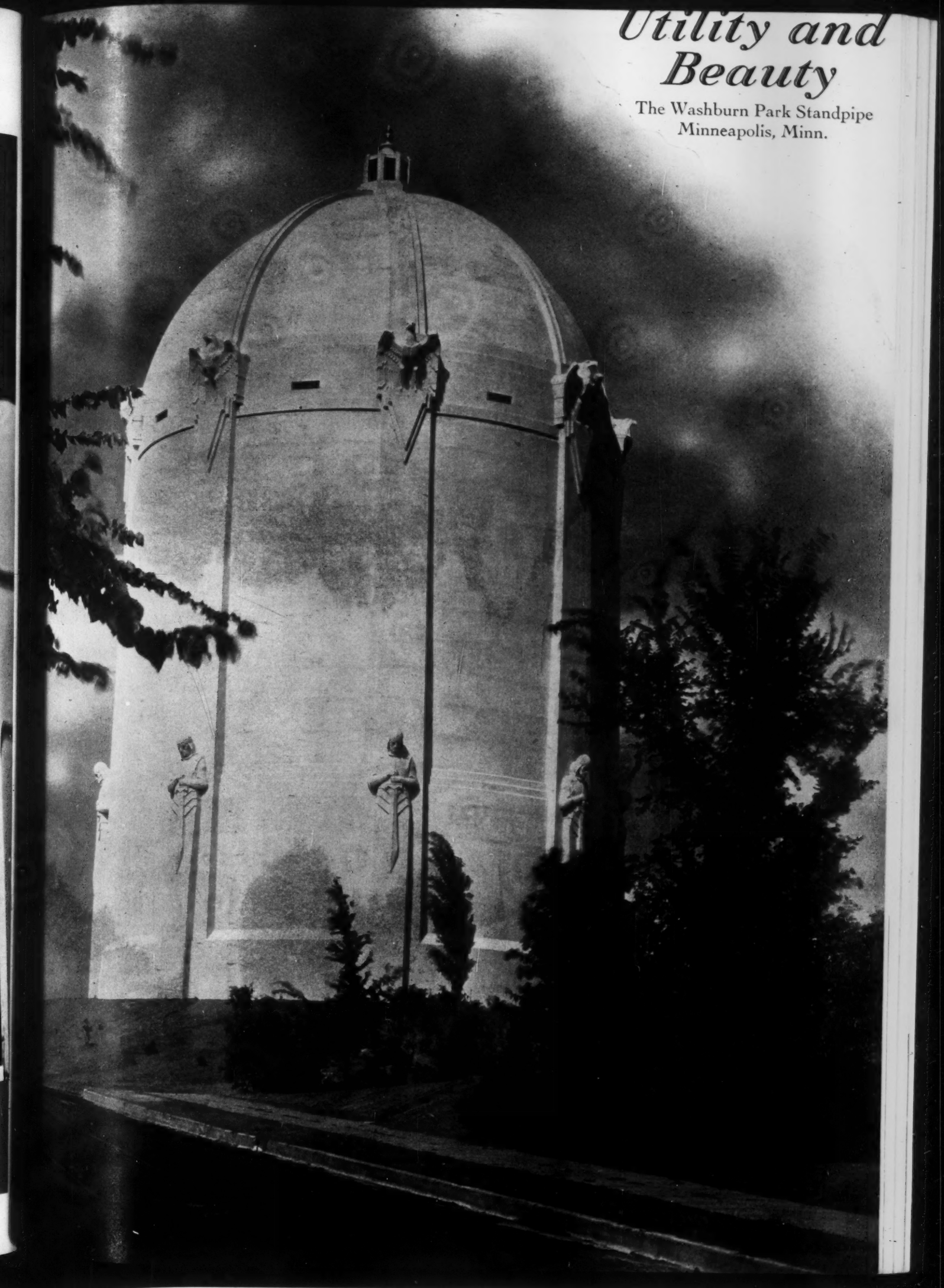

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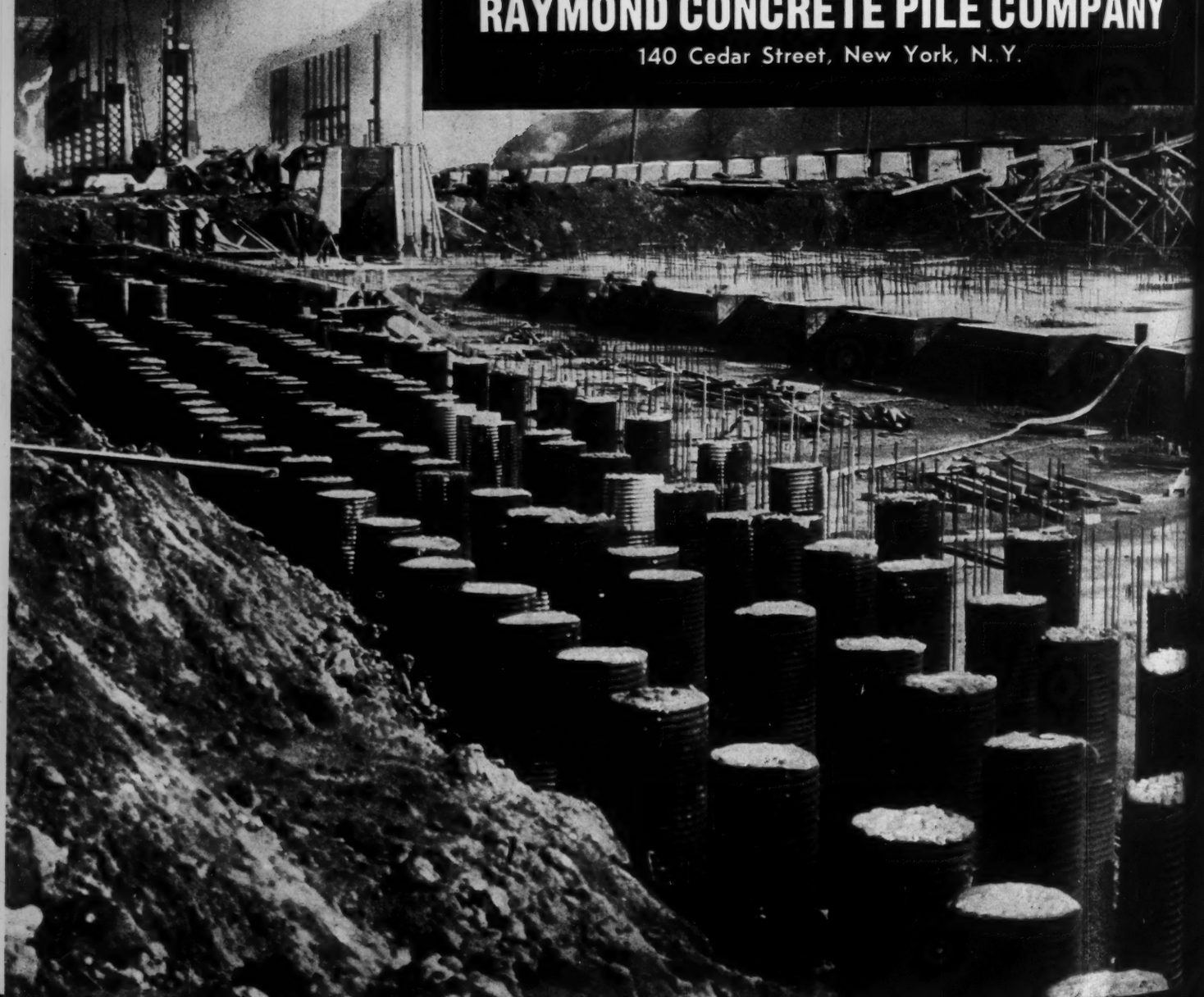

Among Our Writers

HARRISON P. EDDY, whose recent sudden death shocked his numerous friends and admirers, requires no introduction to members of the Society which he served as President in 1934 and as a member of the Board of Direction for 6 years. His prophecy for engineering and scientific developments of the next 50 years is based upon keen observation during a professional practice of almost equal duration.

RALPH SMILLIE received degrees of B.A. and M.A. from Yale and of C.E. from Columbia. He was engineer of designs for the Holland Tunnel and consulting engineer for the Sumner (East Boston) Tunnel. Since 1929 he has been transit engineer for the city subway in Newark, N.J., and since 1933 engineer of design of the Port of New York Authority.

O. J. TODD, before going to France as captain of engineers, U. S. Army, in 1917, served with the San Francisco Board of Public Works, principally as chief hydrographer on the Hetch Hetchy water supply project. Since August 1919 he has been active in engineering work in China, chiefly as consulting engineer on flood control and irrigation projects.

NELSON C. BROWN, a graduate of the academic and forest schools of Yale University, has specialized in forest utilization. He has served in the logging, manufacturing, and distribution phases of the lumber industry, and more recently in a consulting capacity, both in this country and abroad. Mr. Brown is the author of five books on various phases of the industry, as well as a number of articles in periodicals.

ANDERS BULL is a graduate of Christiania, (Norway) Technical College and Columbia University. He was engaged for 15 years in the design of electric railways and power plants, and the development of radiotelegraphy. For 25 years he has been connected with the engineering departments of New York City, making designs and investigations for bridges, elevated railways, subways, and tunnels, with special emphasis on research.

ALBERT E. MARSHALL, a past-president of the American Institute of Chemical Engineers, was born and educated in England. After coming to the United States in 1912, he served 5 years as plant manager of the Davison Chemical Company of Baltimore, Md. Later he went into private practice as a consultant in Baltimore, removing to New York in 1929. He specializes in chemical plant design and glass technology.

SPENCER J. BUCHANAN has specialized in soil mechanics and foundation engineering for the past 8 years, having satisfactorily completed the graduate course offered by the Massachusetts Institute of Technology in this field. As chief of the soil mechanics division, U. S. Waterways Experiment Station, Vicksburg, Miss., he established the first major laboratory of this type for the U. S. Engineer Corps.

JULIAN HINDS graduated in civil engineering from the University of Texas in 1908. In addition to teaching and bridge design, his experience has included 27 years of hydraulic work with the U. S. Bureau of Reclamation and the Metropolitan Water District of Southern California. He has contributed a number of papers to the Society and to other publications. He was awarded the Norman Medal in 1926.

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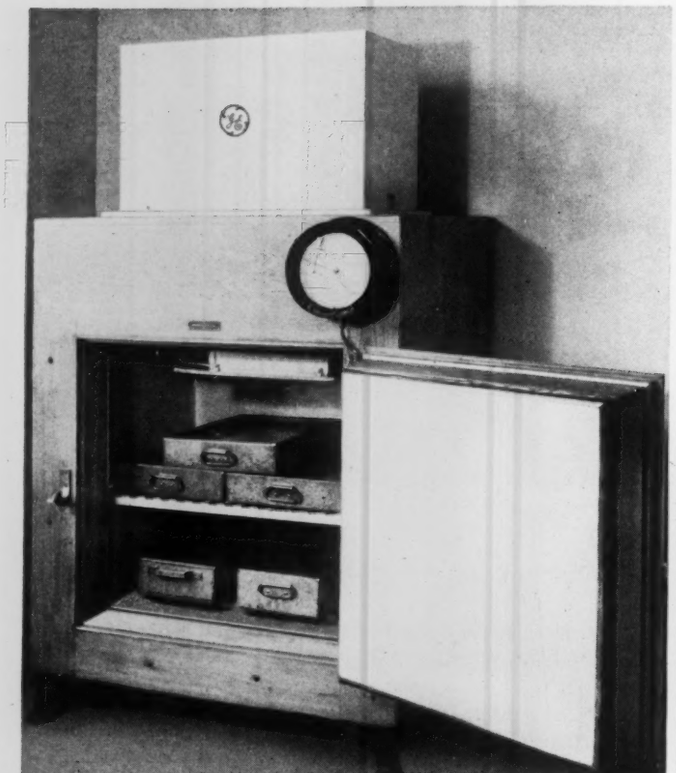
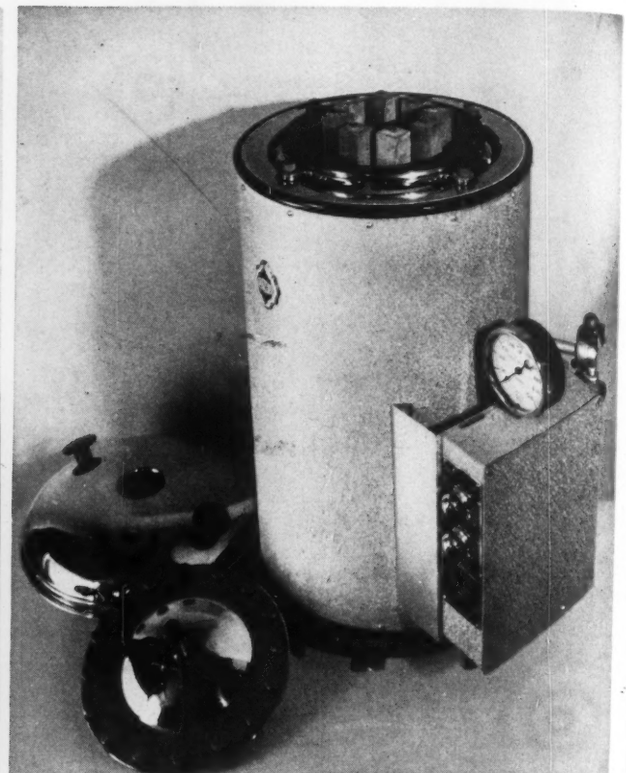


Freezing Machine



Autoclave Machine

THESE dog days seem *cool* when you consider the terrific heat of the autoclave.

The autoclave is the machine shown above, at the right, in which accelerated soundness tests of cement are made. Cement bars are steamed at 420°F in order to detect potential expansion, if any, years before it would ordinarily occur.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Next Fifty Years

By the late HARRISON P. EDDY

PAST-PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS
METCALF AND EDDY, CONSULTING ENGINEERS, BOSTON, MASS.

BUT for his untimely death on June 15, 1937, Harrison P. Eddy would have been one of a notable group receiving honorary membership in the Engineering Institute of Canada at its semicentennial in Montreal that same day. By invitation he had already prepared a paper on "The Next Fifty Years," which was posthumously delivered at a luncheon meeting on June 16. In response to widespread interest, and through the courtesy of the Institute and Mr. Eddy's family, CIVIL ENGINEERING *is permitted to present this address here. Such a privilege is esteemed not only because of the intrinsic merit of the paper itself but particularly because it represents what is undoubtedly the last professional writing, the final effort in international comity, on the part of this highly respected and greatly beloved officer of the Society.*

TO present observers the past fifty years appear to constitute a short period in comparison with the fifty years to come. With respect to past and future, the several professions differ materially in their objectives. The clergyman ministers to present spiritual needs; the doctor treats the current illness of his patient; the lawyer deals essentially with the present as based upon the past. He interprets laws which have been passed, not concerning himself with enactments of the future.

The engineer, on the other hand, deals essentially with the future. As the surveyor determines his forward course by first taking an observation on an established point in the rear, so the engineer utilizes the firm foundation of past experience and accumulated knowledge for the basis of his studies for the future. His bridges, his water works, his main highways, his ships, his communication systems, his machines—all are planned not for the past, not alone for the present, but for the future, often for a generation or more in advance.

A Quickened Tempo in Prospect.—Engineering as a profession has been said to date from about the seventeenth century, but during the past fifty years it has developed to such an extent that we are now living in an "engineering age." Fifty years ago we depended upon man and beast power, whereas today we depend largely upon mechanical means.

In the fifty-year period before us there will be an accelerated advance in the accomplishments of engineering, which, broadly speaking, is the application of science. New discoveries in science, and their use by means of new inventions, will follow one another with ever-increasing rapidity. Often one discovery will reveal a score or more of new opportunities which speedily will be developed and made useful to man.

This acceleration in the speed of engineering advancement will be due in part to the increase in the number of workers in this field, made available through the competition of engineering colleges to gain students, and especially through the growing conviction among parents, whether well-founded or not, that an engineering education carries with it an improved economic and social status. The public has become "engineering-minded."

Promise of the Future.—No one can foretell with accuracy what specific results will ensue from this intensified development along engineering lines; but a few accomplishments are clearly evident:

Space, already so greatly reduced, will, practically speaking, be well nigh eliminated by the conquest of the air.

Mass-production will be extended to far more industries.

Agriculture will yield more and more to combination-control and mechanization. With the aid of new methods of processing and the discovery of synthetic foods, the necessary agricultural products for a unit of population will be provided with a fraction of the labor and land now used.

Automatic control of production and operation will further greatly reduce the need for manual control.

New scientific discoveries, new sources of power, and the development of new processes and inventions, will make necessities and many luxuries more generally available.

Such changes will inevitably shorten the work-time required to satisfy the demands of the public. In Canada and the States it has been reduced one-third during the last fifty years. Is it not probable that an

equal reduction will result in the next fifty years? If so, the required work-time will become only one-half what it is at present. Probably twenty hours a week is a conservative estimate.

Whatever this reduction may be, it will result largely from the activities of the engineer. Credit for lightening the human burden, however, will be accompanied by liability for any unfortunate results which may ensue, and the public will look to the engineer to provide the means to avoid them.

How Dispose of Added Facilities?—One of the greatest problems which will be created by such changes and which even now is urgently demanding attention is:

What shall we do with our released time and energy?

Some of the ill effects of a surplus of spare time already have become evident. Among a substantial number of persons there has apparently developed a lack of desire to work for the purpose of bettering their condition. To illustrate, it has recently been found so easy to do a minimum of work for a modicum of compensation, under the guise of relief, that the incentive to produce more for a greater reward has become atrophied. This tends toward a falling, not a rising standard of living.

We are wont to believe that our modern civilization has produced a higher standard of living. Unless this great problem of the application of leisure time is judiciously solved, the undirected forces of human nature may reduce the present standard of living and wreck our civilization.

> "For Satan finds some mischief still
> For idle hands to do."

will be as true as when stated by Isaac Watts.

Recreation Is One Attractive Possibility.—The most obvious and popular solution of the problem seems to be the development of recreation, and in the next fifty years games, sports, hunting, fishing, travel, and a long list of recreational pursuits will be brought within easy reach of more and more of the people. In providing such means, the engineer will take a prominent part. New machines and equipment will be invented and used partly or exclusively for recreation; greater sums will be spent, for the most part under the technical direction of the engineer, on the development of highways, playgrounds, parks, and other facilities. While this movement is valuable, is it to be the sole solution of the problem during the next fifty years? Can recreation take the place of work in providing training and discipline?

It has been said that

> "Obedience to law is liberty."

Will the making available of so large a proportion of time for play result in producing a lack of respect for, and obedience to law? Will it diminish initiative and ambition? There certainly is grave doubt whether the solution can be found in recreation alone.

What Education Has to Offer.—Another promising solution lies in the field of education. To quote Mr. H. G. Wells (*A Year of Prophesying*, 1925):

> "In the last two centuries . . . there has been much more than a tenfold increase in speed and a corresponding increase in security, versatility and comfort. Our mechanical power and mechanical productivity have increased in far greater proportion. There has been an educational advance also, but it has not kept pace with this. . . . The education of a fully educated man is not conspicuously better than it was two hundred years ago. . . . We believe that we are now in the dawn of a phase of educational thrust corresponding to the mechanical thrust of a century ago."

In harmony with Mr. Wells' prophecy I foresee a longer period of education for youth, extending perhaps to the completion of a junior college course, say at the age of twenty. This will provide a general education including opportunity for trade and vocational training, but it should not be continued too long, because youth is anxious to begin its life work; it is "champing at the bit"; its zest and ambition must not be permitted to wane.

Even Adult Training Will Supplement Schooling.—In addition to this general education, post-scholastic study will become much more common and will provide both for entertainment and for the development of handicraft, science, the arts, and literature. It will continue through adult life. There will ensue a return of the craftsman, who will work for the pleasure of working and to produce useful and ornamental things in the making of which he will take a just pride. The pursuits of art and literature are appropriate home avocations. Study and research in the home are not impracticable, and for the more involved work, laboratories open to the public could be provided, where research could be carried out with adequate equipment and technical guidance.

The professional engineer of the future will be more highly educated than in the past. His four-year college training will be devoted to the fundamental sciences with generous allowances for the liberal arts and humanities. His professional study will follow in what we now call "postgraduate" years. He will then have a service period of several years before he will formally enter the profession. Only by such modifications of the present prevailing college training can the engineer of the next fifty years be adequately equipped, or attain to the plane of responsibility which will be open to him if he is qualified to occupy it.

Great Possibilities Ahead.—Providing for the future as his work necessitates, recognizing and applying the discoveries in science, and appreciating that there is a vast realm of the unknown yet to be explored, from which new truths are still to be learned, the engineer must be progressive and at the same time sound; he must distinguish fallacies from truths. If he takes advantage of his opportunities during the next fifty years, the engineer will exert a greater influence upon the progress of civilization and the well-being of mankind.

The scope of our engineering societies must be broadened. They must maintain a high technical standard through interchange of the results of experience and research; but they must also devote more time and energy to the study of economic, social, and governmental problems, both national and international. Only by applying the facts, laws, and lessons of science to the development and control of human nature can our engineering societies maintain their position of leadership.

LOUIS C. HILL
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CIVIL ENGINEERING

AUGUST 1937

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VOLUME 7

NUMBER 8

Design Features of the Lincoln Tunnel

As Developed for the South Tube Shortly to Join Manhattan Island and Weehawken, N.J.

By RALPH SMILLIE
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER OF DESIGN, THE PORT OF NEW YORK AUTHORITY, NEW YORK, N.Y.

DRASTIC changes in the basic transportation pattern for vehicular traffic seem to be inevitable in American cities just at present. Vast sums are being expended to simplify travel habits and expedite movements through or around congested areas. Many such major improvements have been undertaken near New York City. One, now nearing completion, is the Lincoln Tunnel connecting Weehawken, N.J., with 39th Street, Manhattan—the subject of this paper. Although Mr. Smillie avers that the advances incorporated were more in the nature of refinements in existing practice than basic improvements in design or construction, his interesting account tends to belie his modest disclaimer. New methods of lining, both for upper surfaces and for the roadway, were adopted. The description of ventilation facilities as well as of the portal plazas and their control will also prove enlightening. This informative paper supplements that by O. H. Ammann, M. Am. Soc. C.E., in the June issue, giving the background of the project.

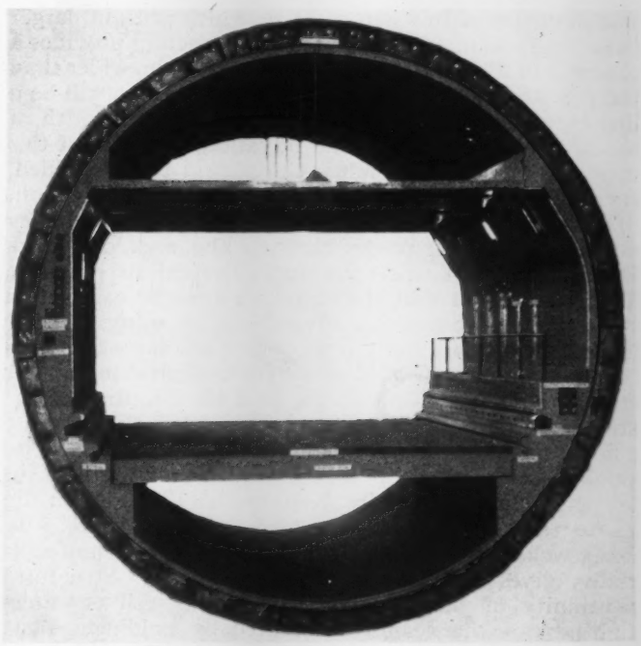
ANOTHER important addition to the vital traffic connections between New Jersey and New York will be inaugurated early in 1938, when the first unit of the Lincoln Tunnel will be opened for public use by the Port of New York Authority. There will then be three vehicular crossings from Manhattan Island to New Jersey operated by that body. The Holland Tunnel, opened in November 1927, was followed five years later by the George Washington Bridge.

Now comes the Lincoln Tunnel. It crosses the river from West 39th Street, Manhattan, to Weehawken, N.J., and furnishes direct service to Manhattan's midtown district. In its final stage it will consist of two separate tubes, each providing for two lanes of traffic. When construction was started in 1934, considerable difficulty was experienced in financing so large a program as that involved in a double tunnel. Construction therefore was begun on the so-called "first operating unit." This was the south tube of the two which will be built finally. In the fall of 1936, with improved economic conditions, arrangements were completed for financing the entire project. Thus the second, or north tunnel, was put under contract early in 1937.

Intended for use by motor vehicles exclusively, the Lincoln Tunnel has the general features of other structures of its type. And since it is the most recent, it embodies definite engineering advances. The principal points of difference from the Holland Tunnel are increased diameter, wider roadway, and such modifications in design and construction as have been brought about by local conditions and the nature of the materials encountered.

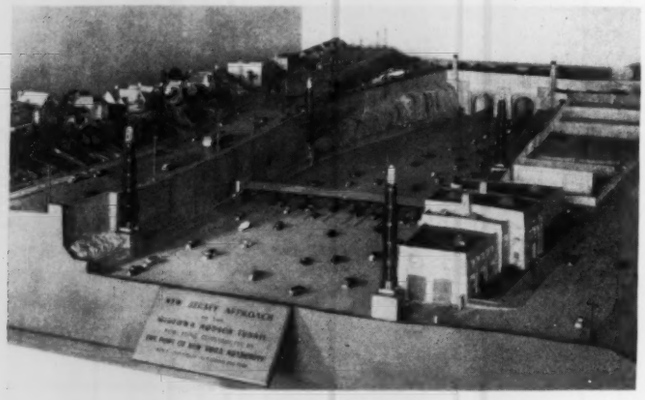
In planning the crossing, certain major problems of tunnel design, plaza layout, and ventilation were presented. The general questions of locating the tubes and of planning the approaches have been discussed by O. H. Ammann, M. Am. Soc. C.E., in his article, "Planning the Lincoln Tunnel Under the Hudson," in the June 1937 issue. With these preliminary decisions made, the design problems have become narrowed down to those involved in building a tunnel under the river at the site selected.

The south tunnel, now nearing completion, is 8,215 ft long between portals. It consists of 240 ft of cut-and-cover construction beginning at the New Jersey plaza, 785 ft of structural-steel-lined rock tunnel under King's



MODEL OF CROSS-SECTION OF LINCOLN TUNNEL

Bluff, 5,920 ft of cast-iron and cast-steel lining under the river (largely in Hudson River silt), 450 ft of structural-steel-lined rock tunnel east of the land ventilation building in New York, and 560 ft of cut and cover extending eastward from the western side of the New York Central Railroad right of way to the New York portal. Approximately 260 ft of tunnel forms part of the foundation shafts for ventilation buildings.



Model Shows Ultimate Development, Looking North

Same Site During Progress of Construction

NEW JERSEY PLAZA TAKES FORM

TYPES OF LINING TO MEET SPECIAL NEEDS

In the main section the lining is of cast-iron of conventional design. This part of the tunnel was built by the shield method using compressed air. Each ring consists of 14 regular segments plus a key segment, all fastened together with bolts of high tensile steel, $1^3/_4$ in. in diameter. These rings are 30 in. wide, with 14-in. flanges and $1^5/_8$-in. webs. In design they conform generally to those used in the Holland Tunnel.

The iron-lined portion of the tunnel extends from a ventilation shaft on the west foreshore of the Hudson, under King's Bluff in New Jersey, to Eleventh Avenue and West 39th Street in Manhattan (Fig. 1). The outside diameter of this part is 31 ft, which is 18 in. larger than the Holland Tunnel. This construction provides a roadway of 21 ft 6 in. between curbs, or 18 in. wider than the previous tunnel. In the initial stage there will be a line of traffic in each direction. The greater width of roadway will be of particular advantage because of this opposing movement. When the second tube is added, each will be limited to traffic moving in one direction.

Between the ventilation shaft and the New Jersey portal, the tunnel passes through the rock of King's Bluff. This part was built under normal air pressure. The requirement that the structure must be completely watertight indicated the advisability of using a metal lining. Hence alternate bids were invited, on the basis of either a light cast-iron, or a structural-steel lining. A considerable saving in cost dictated the adoption of the steel construction. It differs in several respects from the conventional liner plate design: the skin plates are $^1/_2$ in. thick; each segment is 5 ft in width and 112.8 in. in length; side flanges, 8 in. deep, are cold pressed on the plates; and end flanges are welded. A half I-beam, 8 in. deep, welded to the center of the segments circumferentially, gives stiffness to the entire plate. Structural continuity of the central I-sections, as well as watertightness of the seams, is secured by welding. Thus the lining forms a waterproof lining, as well as a structural member strong enough to resist any bending stresses that may be imposed upon it. The concrete placed between the flanges performs primarily the function of making a flush surface on the inside of the tunnel and also affords protection to the lining against corrosion.

On the Manhattan end, from the portal at Tenth Avenue to the New York Central Railroad Company's right of way, the construction was in open cut. In the course of excavation, the ground water was found to contain gasoline and oil. As every effort to stop this flow at its source failed, it became evident that waterproofing resistant to oil would have to be used. This section is protected by electrolytically deposited sheet copper, in addition to asphalt waterproofing. Because this membrane is very thin, weighing only 3 oz per sq ft, a felt backing was provided to give mechanical protection during handling. The concrete sand wall was given a prime coat of chlorinated rubber varnish. Synthetic rubber cement was used as a sealing material as well as a means of holding the copper in place on the sand wall until the interior concrete could be poured.

SURFACING FOR ROADWAY AND WALLS

As two-way traffic will be necessary in the initial stage of operating the Lincoln Tunnel, it will be essential to keep the traffic lanes separate. To accomplish this, two lines of lane markers, 8 in. apart in the clear, are placed in the center of the roadway. These markers are white glazed porcelain, the size of half a paving brick, or roughly 4 in. square, staggered alternately with the standard red bricks of the paving. At intervals of 50 ft, and closer on curves, raised illuminated markers form a line of lights in the center of the roadway visible in both directions. These will give a permanent and prominently visible line of separation. The practice of using a painted line has proved unsatisfactory owing to the difficulty of maintaining it during heavy traffic where one lane cannot be shut off. The two lines separated by the lighted fixtures will deter drivers from crowding the line and will increase the space between opposing lines of vehicles.

The pavement itself is of de-aired vitrified brick set on a $^3/_4$-in. mastic cushion. Although vitrified brick has been used as a paving material for a long time, its adoption for vehicular tunnels is new. The reasons leading to the selection of this material were its durability, its ease and rapidity of renewal, its smooth surface, its moderate cost, and its shallow depth. The last factor is important where space is at a premium.

Because of the difficulty of maintaining exposed concrete surfaces in a presentable condition, such surfaces have been reduced to an absolute minimum. The in-

terior lining of a tunnel is always subject to severe deterioration; to be durable, it must be of high quality. Because of the constant introduction of fresh air in operating the ventilation system, the temperature range in the tunnel approximates that of the outside air. Exposed surfaces must thus withstand extremes of temperature variation, as well as the abrasive effects of cleaning operations.

These requirements have been approached, if not entirely met, by using glazed terra cotta for the facing of the bench below the sidewalk, as well as for the nosing opposite, and by lining the walls between the sidewalk level and the ceiling with cream-colored vitreous ceramic tile set in a mortar bed directly on the concrete of the tunnel. While this upper lining follows previous accepted practice, the use of glazed terra cotta is a new departure.

GLASS TILE FOR CEILINGS—A NEW FINISH

The ceiling presented a special problem. Concrete alone has not proved satisfactory. It accumulates deposits of vaporized oil, water, and dust and soon becomes unsightly. Frequent repainting is expensive; furthermore, the results of repainting have been generally unsatisfactory. The use of ceramic tile on the side walls indicated that a similar surface would be advantageous for the ceiling. But it could not be applied in the conventional manner with any assurance that it would not come off and cause damage or possibly serious injury. The design adopted consists of 6-in. by 6-in. glass tile grooved on four edges. Each tile is held in a separate metallic gripper of special design, formed from a sheet of No. 22 gage commercial bronze. The plate forming the gripper has the four edges turned up or flanged, forming in effect a shallow pan in which a tile is placed. The flanged edges of the gripper are bent to form a bead or projection which engages the grooved edges of the tile. Thus a tile can be sprung into a gripper with a slight pressure as long as the gripper edges are free to move. After the joints between tiles are grouted the tile is securely locked in place. To retain the gripper in the concrete on the under side of the ceiling slab, a hole is punched in the center of the bronze plate and the edges of the hole are turned up or flanged at an angle of 45 deg thus forming a hollow truncated cove on the back of the gripper. Tiles assembled in the grippers are set face down on gummed paper on the ceiling forms. After the joints have been grouted to prevent displacement, reinforcement is placed and the concrete slab poured. The grippers, each holding a tile, thus become embedded in the concrete slab.

Before this method of construction was adopted, extensive laboratory tests were made to determine the practicability of pouring concrete without displacing the tile on the paper. Tests were made to determine if the gripper would have adequate holding power in the concrete slab, and to what degree the tile would participate in the stresses in the slab.

Bidders were given the option of furnishing glass or ceramic tile for the ceiling construction. Owing to the difficulty of grooving and sizing the hard-bodied ceramic tile specified, no bids were received for this material. Hence glass tile was adopted.

Drainage water in the tunnel is collected at six sumps. There is one near each portal, one under each of the three ventilation buildings, and one at the low point, near the middle of the river. The sump at the low point presented a problem in that it was necessarily located in soft ground in the shield section of the tunnel. This sump is a section of the lower air duct. Below it is a small well 5 ft 6 in. in diameter containing the foot valve of a small triplex pump. The bottom of this well was built at the same time the cast-iron tunnel lining was erected. After the shield had passed the low point, the well was jacked down by placing horizontal cast-iron rings on the bottom well castings. As the jacking progressed, additional horizontal rings were added until a depth of 8 ft 6 in. below the tunnel invert had been reached. The special tunnel segments holding the sump castings, as well as the sump rings themselves, were assembled with turned bolts and machined as a unit. Only $^1/_{16}$ in. of clearance was allowed between sump and tunnel lining.

PLAZAS DESIGNED FOR MULTIPLE USES

Topographic conditions on the two sides of the river called for widely different treatments in the arrangement of the plazas. The New Jersey plaza, built in deep cut between retaining walls, occupies an area between King's Bluff on the east and the general plateau of the Palisades to the west. As tolls for both eastbound and westbound

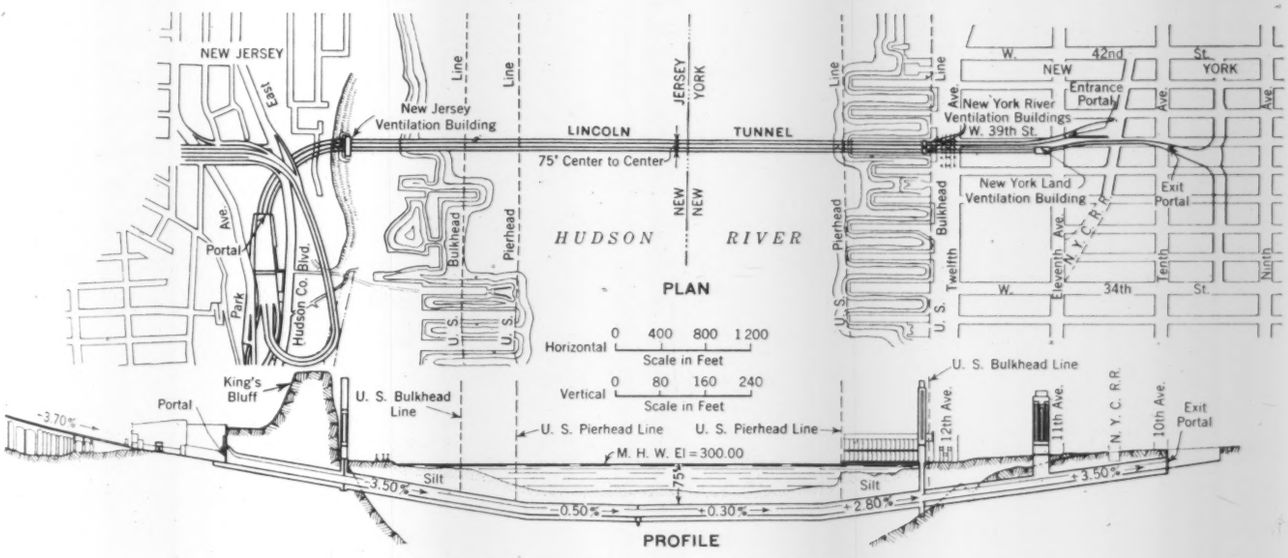
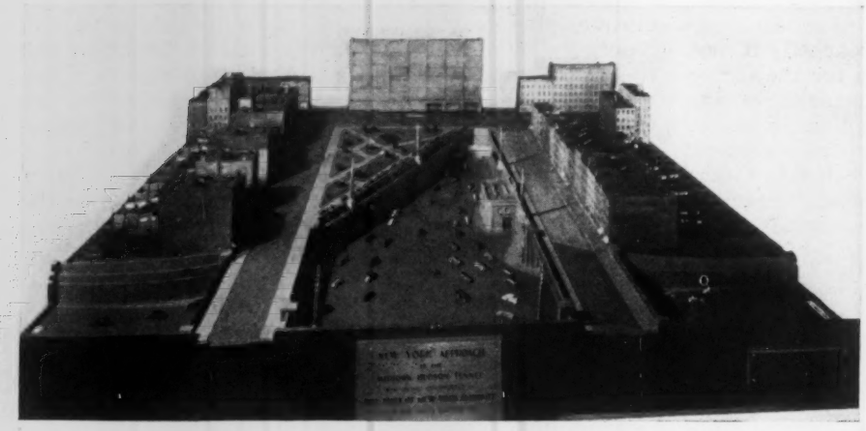


FIG. 1. PLAN AND PROFILE OF LINCOLN TUNNEL

From Portal to Portal the South Tunnel Is 8,215 Ft Long; the North Tunnel Will Be About 7,400 Ft

traffic will be collected at this point, in both the initial and final stages, stopping of vehicles in both directions must be provided for. Ample storage capacity is obtained in this plaza, which is more than 900 ft long; its width of 180 ft provides for 13 traffic lanes.

Toll booths and equipment for vehicular counting and toll recording are located under a canopy extending across the plaza. On the east side an administration building houses the office force as well as provides facilities for police, medical officer, shops, and storerooms.



APPROACH AT NEW YORK END OF TUNNEL
Scale Model in Ratio of One-Eight Inch to One Foot

All retaining walls around the New Jersey plaza are of the reinforced-concrete cantilever type, those on the westerly side adjacent to Park Avenue being 70 ft high from the bottom of the footings to the upper ground level. The higher walls are drained by means of a gallery at the level of the top of the footings. This gallery, which is large enough to walk through, provides positive drainage for the soil back of the wall. Thus it eliminates weep holes, which are unsightly and subject to clogging. The cost of these galleries was small, inasmuch as the excavation was required anyway for the wall footing, and the floor and one wall of the gallery are formed by the retaining wall itself.

The New York portal of the south tunnel is located at the southeast corner of Tenth Avenue and West 39th Street (Fig. 1). Beyond the portal the tunnel widens out into an open plaza. In the initial stage this plaza will be used for two-way traffic, but will ultimately become an exit only. The structure is in deep rock cut enclosed by brick and granite-faced retaining walls. At the easterly end it connects with a new north and south avenue midway between Ninth and Tenth avenues, extending from 34th Street to 42d Street. In the plans for the 38th Street crosstown tunnel projected by the City of New York to connect the Lincoln Tunnel with the new East River tunnel at East 38th Street, Manhattan, provision is made for carrying the Lincoln Tunnel traffic eastward from the exit plaza. The new north-and-south avenue has been named Dyer Avenue by the Port Authority in memory of the late Gen. George R. Dyer, former chairman of the Authority. On the north side of the plaza there will be a building housing emergency equipment to take care of stoppages in the tunnel.

In the final stage there will be an entrance plaza for the north tunnel one block north and west of the exit plaza. Here another new avenue (also shown in Fig. 1) will be built west of Tenth Avenue, for westbound traffic. This has been named Galvin Avenue in memory of the late John F. Galvin, also a former chairman of the Authority.

ELABORATE VENTILATION REQUIRED

The method of ventilating the Lincoln Tunnel is in general similar to that used in the Holland Tunnel. In this system air is fed in at the shafts, thence passing through a duct under the roadway. It reaches the roadway through flues placed at intervals of from 10 to 15 ft, depending on the static pressure in the main duct. Each fresh-air flue is provided with a plate at the point of junction with the lower air duct so that the area of the flue may be constricted to admit the proper amount of air. After mixing with the exhaust gases, the vitiated air is drawn off through ports in the ceiling to an exhaust duct over the roadway. Although this is not the most economical method of ventilation from the standpoint of friction losses, because of the necessarily restricted duct area, it results in a minimum of air flow in the roadway space.

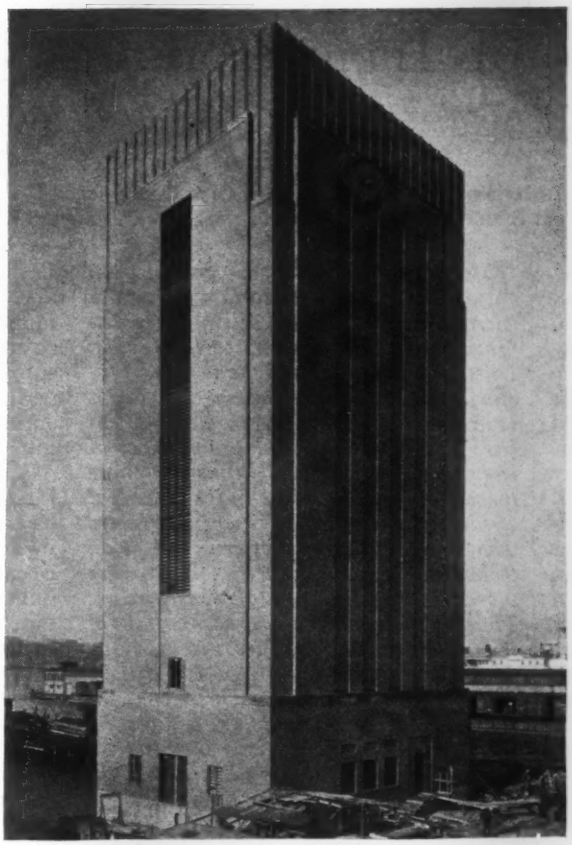
In the Lincoln Tunnel, air will be handled by 56 fans, all of the double-inlet, backwardly curved blade, centrifugal type. In general there are three fans on each duct section, one of which constitutes a spare. In the case of the river sections, there are three blower fans and four exhaust fans. All equipment, except spares, operating at full speed, will deliver 3,375,000 cu ft of air per min to the tunnel, and withdraw an equivalent amount, making allowance for a decrease in density.

The fans with their motors and control units will be housed in three ventilation buildings. Two of these are located inshore and have conventional foundations. The third, which will consist of twin buildings for the completed project, is located in the slip just west of the New

NEW YORK APPROACH UNDER CONSTRUCTION
View Shows Close Resemblance to Model Pictured Above

York bulkhead line. The foundation for this twin structure consists of concrete-filled steel caissons, similar to those commonly used for shield tunnels. The lower parts of the caissons were built in a shipyard and towed to the site. There the upper parts were completed as the caissons were sunk into position and landed on bedrock. During sinking the skin plates above the river bottom were covered with a protective layer of concrete. Between wind and water, granite was used as a protection.

Above the tops of the caissons the ventilation buildings themselves mushroom out on heavy cantilever girders, the buildings being larger than the caissons in both directions. In all three ventilation buildings, reinforced brick has been used to stiffen the high unsupported parapets and the large brick panels which are subjected to wind and static pressure from the fans.



NEW YORK RIVER VENTILATION BUILDING
Of Modern Reinforced-Brick Construction

SOME INTERESTING FAN DETAILS

Ample ventilation must be provided for in case of traffic jams or fire, although under average conditions much smaller quantities of air are sufficient. This results in a low load factor, and calls for fan drives which will permit large variations in both speed and horsepower with reasonably high efficiency. Variations in the quantity of air may be secured in many different ways; almost as many different methods have been employed as there are vehicular tunnels. All methods have inherent disadvantages, so that the final selection must be a compromise between system losses on the one hand and high first cost and maintenance on the other. The diversity of systems is due not so much to different methods of attacking the problem as to varying local conditions.

In the Lincoln Tunnel all fans, except those serving the long duct sections under the river, will be chain driven by two-speed or three-speed squirrel-cage motors. In the river sections, where higher static pressures are required, it was practical to use direct drive for the higher speeds. Four speed-steps are used on these units, the two higher ones being obtained by two-speed motors having synchronous speeds of 450 and 300 rpm. For the two lower rates, namely, about one-half and one-quarter speeds, the large motor runs idle and is driven by a separate two-speed motor geared down to appropriate fan-shaft speeds. When the large motor is operating, the small motor is cut out of service by means of an overrunning clutch. According to the cube law, with operation at one-quarter speed the fan horsepower is only one sixty-fourth that required at full speed, so that the fan drive should be efficient over a wide range of speed and horsepower.

Speed control of the motors presented a special problem. All motors are designed for full-voltage starting. In going from higher to lower speeds it is essential that the lower speed step should not come in until the motor has slowed down to its proper speed, because of the high counter torque which would otherwise result. Time elements and centrifugal governors were rejected as being unreliable. The design adopted embodies a new principle as applied to speed control. It consists of a tuned frequency circuit, the energy for which is furnished by a small magneto, gear-driven from the end of the fan shaft. The frequency of the current in the circuit varies directly with the speed of rotation of the fan. This circuit, by proper adjustment of capacitance with relation to reactance can be made to produce a sharp increase of current at critical frequencies. Relays responsive to this increase in current cause the motor-starting contactors to operate at frequencies corresponding to the proper points of motor speed. In addition to their function of motor control, the magnetos operate voltmeters calibrated to provide speed indication at the supervisory control board.

Control of electrical equipment for all parts of the tunnel is centralized in a supervisory control room in an upper floor of the New Jersey ventilation building. This room contains a central control board, by means of which the operator can perform switching operations which determine the distribution of energy from the power supply on both sides of the river as well as the speed of fan motors and the control of lights and auxiliaries. This board also gives indication of the operating position of all circuit breakers, pump control, and other operations, as well as the speed of the fans and the position of their dampers.

Fan operation may be controlled from local boards in each building, and from a point near each fan. In the main control room is also located a board on which are mounted the potentiometers, which give a continuous graphic record of the carbon monoxide content of the exhaust air in each duct section of the tunnel. A traffic board gives control and indication of all tunnel traffic signals. Adjacent to the control room are telephone switchboards serving the private tunnel telephone system, as well as a Bell telephone board for outside calls.

In general the design of the Lincoln Tunnel has followed traditional lines. From a purely structural standpoint there have been no major problems. The new features constitute refinements of detail directed towards improved appearance and reduced maintenance cost. The innovations in the electrical and mechanical equipment are along the lines of ruggedness and low operating cost. The Holland Tunnel has served as a valuable laboratory and proving ground where many new features were tested under actual operating conditions before being incorporated in the design of the Lincoln Tunnel.

The Progress of Irrigation in North China

Modern Structures Replace Primitive Means for Distributing Water

By O. J. Todd

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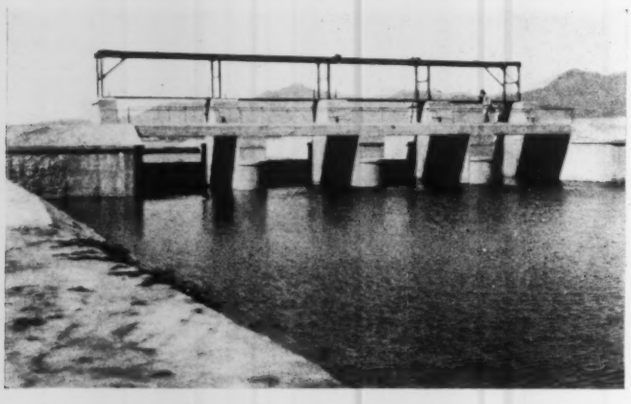
PERIODS of prolonged drought seem to be occurring in North China with increasing frequency, causing repeated famine and suffering among the people. During the past decade the various provincial governments (and in one case a semi-American philanthropic group) have undertaken to develop a number of irrigation projects and conserve more thoroughly available flow in the principal streams. In this movement engineers who have studied Western irrigation technique have endeavored to introduce more modern methods of construction. Four of the larger and more important of the projects included are discussed by Mr. Todd in the accompanying article. Apart from the design questions involved, readers will find Mr. Todd's description of construction methods of particular interest as illustrating the contrast between labor conditions in China and in the United States.

CHINA's Northwest, including the provinces of Kansu, Ninghsia, Shansi, Shensi, and Suiyuan (Fig. 1), is frequently visited by disaster in the form of a prolonged drought. Ninghsia has garden lands close to its provincial capital, where river bottoms have been irrigated for many centuries by the water of the Yellow River, and Suiyuan has had a very crude irrigation system in the Haotao region near the Ninghsia-Suiyuan border, where the Yellow River is also the source of supply. Nevertheless that river has not been utilized to its fullest extent. Similarly in Shansi on the Taiyuan plain there is an archaic system for irrigating lands from the Fen Ho, but the system needs many improvements before the term "water conservancy" in a modern sense can be applied to that river. Likewise the King Ho, the Lo Ho, and the Wei Ho in Shensi Province were not utilized to any considerable degree until recently, although for over 2,000 years the King Ho had been drawn upon to some extent to water the Wei Pei plain lying north of the Wei Ho.

Within the past few years considerable headway has been made towards introducing Western methods in order to get the most economical use of the water, as the adjoining country is dependent upon these areas for better and steadier crop production. Recent studies of climatologists and geologists have produced some evidence that China's Northwest is becoming drier at a rate more rapid than other sections of the country. Drifting sands from the Gobi Desert on the northwest are burying farm lands in northern Kansu that formerly produced good grain crops. The Ordos region, immediately north of Shensi, between the Great Wall and the Yellow River, is now a country of sand dumes, although less than a thousand years ago farming communities were situated there. Relics of the Nestorian Christians and the Scythian settlements are found in the shifting sands that now cover the area. Unless rainfall is supplemented by other sources of water supply for growing grain, constantly recurring drought famines must be expected.

Unfortunately China's Northwest, for topographical as well as for hydrological reasons, does not lend itself readily to many large-scale irrigation developments. Heretofore only small projects had been carried out, bordering the larger streams or utilizing streams and springs of very limited capacities. But during the past seven or eight years a new movement has been under way to develop larger projects and more thoroughly conserve available flow in the principal streams. Of these larger projects four are very important and have been carried well along towards completion. These are the Saratsi in Suiyuan Province, and the Wei Pei, Lo Ho, and Wei Ho in Shensi Province. The Wei Pei project has been in full operation for the past year.



Main Intake Gate Structure for the Saratsi Project

SARATSI PROJECT UTILIZES FLAT GRADIENTS

The Saratsi project utilizes the Yellow River for its supply at a point ten miles below the western terminus of the Peiping-Suiyuan Railway, 450 miles northwest of Peiping. The main canal, which has a bed 60 ft wide, extends to the east for over 40 miles. The Yellow River flows in a southwestern direction at this point, thus making a triangular area to be served by the canal system. Main laterals, leading off at three-mile intervals, extend to the south nearly to the river.

This region, known as the Saratsi plain, is so flat that the gradient of the main canal had to be established at 1:8,300. With silt-laden water there will be a cleaning problem each year, but fortunately the maximum silt content at the intake of the canal has been found to be less than 4 per cent by weight at flood time and less than 1 per cent in ordinary stages of flow. (This contrasts sharply with conditions on the other canal systems to be discussed later.) Experimental irrigation carried on in 1935 and 1936 (before this project was completed), indicated that, in the early spring when the ice jams break, the fairly silt-free water will help to clear out some of the silt that is deposited in the autumn months.

This entire region is one of short summers and sparse rainfall, where agriculture without irrigation is as hazardous as in much of the United States just east of the Rocky Mountains, and it will therefore never be very densely populated. But where irrigation is moderately successful, an outlet will be furnished for some of the surplus population of the Shantung and Hopei plains.

Private enterprise would not have ventured to try to

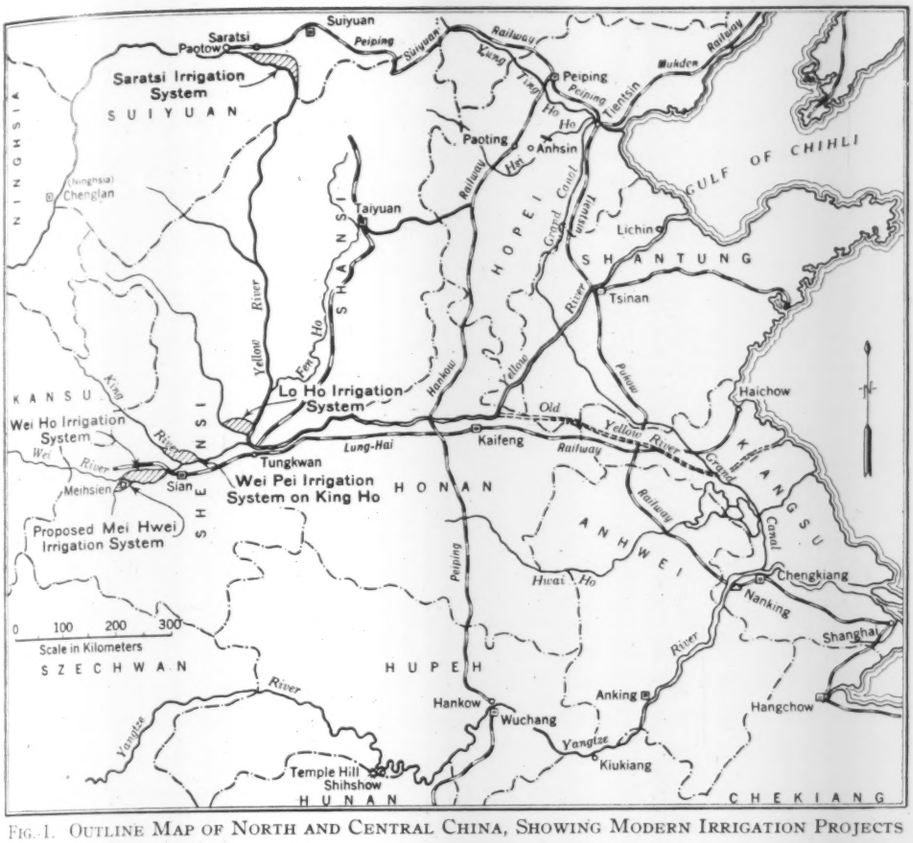


FIG. 1. OUTLINE MAP OF NORTH AND CENTRAL CHINA, SHOWING MODERN IRRIGATION PROJECTS

solve this problem, but the severe drought famine of 1928–1929 led a semi-American philanthropic group to bring in funds which made it possible to proceed with the undertaking. Because of insufficient financing, the project has never been entirely completed, although for the past two years it has been in partial operation.

Interesting features of the project are the lack of any means for storing flood waters and the difficulty of providing gravity flow over the entire area to be served. (Pumping will be too expensive until the population has been multiplied many times.) Most of the irrigating must be done in the autumn right up to freezing time, the fields remaining soaked until spring, as the rainfall occurs chiefly in July and August.

The crops usually raised in this region are millet, oats, wheat, flax, beans, hemp, and kaoliang. It is not yet practicable to introduce sugar-beet growing, and the project is too far north for successful cotton-growing. But the water supply from this canal system will so supplement the ordinary rainfall as to insure a far greater regularity in staple crops than has been possible before. That is what Suiyuan needs at this stage of its development.

Sufficient structures, including masonry head-gates, check-gates, lateral head-gates, and wooden bridges, have been built in the Saratsi project to make it meet the requirements of the community. Sublaterals will be dug by the farmers with partial aid from the management of the project, and a system of drainage ditches will follow. The project will be improved as population comes in, since there is no rich Uncle Sam in China to spend even as much as $10,000,000 on a single project.

RECONSTRUCTING THE WEI PEI SYSTEM

In view of its long history and its location near an important political center of antiquity, the Wei Pei project is perhaps the most interesting of the four discussed. This project is located in central Shensi, to the north of Sian. Here much of the surrounding country is rolling or mountainous, but the Wei Pei plain with its several terraces constitutes an area of nearly a million acres of good farm land, and has been known for centuries as the "granary of Shensi." Because of its fertility and extent, the early Chinese made the plain of Wei Pei their first center of civilization.

Coming out of a rocky gorge into the Wei Pei plain from the northwest, the King River joins the Wei River on the plain twenty miles farther east. The King River has been tapped for irrigation purposes at various periods since the first irrigation system was built in 240 B.C. to insure this farming district against drought famine.

The canal system of 240 B.C., constructed a few miles below the mouth of the rocky gorge, was neglected until it became almost useless, and in 96 B.C. a new canal system was built. Through the following centuries this was succeeded by several similar projects, the intake being moved a little farther upstream each time, until finally the rocky canyon was reached. But no adequate head-works were ever installed, so that difficulties occurred both with the floods and with their tremendous mud loads. Cleaning the mud from the main canal became a very expensive operation as the dumps along the banks rose higher. As a result the river-intake canal was closed about 300 years ago, and the flow from springs, entering the canal in its upper section, became the sole supply for irrigation.

After the severe drought of 1920–1921, the Shensi authorities were urged to reconstruct this ancient canal system on more modern lines, with a view to using the available flow of the King River to its maximum capacity. Plans were adopted in 1930 for constructing the new Wei Pei irrigation system. As early as 1924, I had been called in to visit the project as a consultant, but it was six years before I returned supported with adequate unds to go forward with the work. A new drought, occurring in 1928–1929, had in the meantime warranted the granting of funds both by famine-prevention agencies and by the local provincial government. Work was begun in December 1930, and completed in 1935. The project irrigates 100,000 acres of the Wei Pei plain.

A masonry overflow dam 215 ft long was built in the canyon to divert the flow through a tunnel 1,300 ft long in limestone rock. A portable air-compressor from America aided the hand-drilling here. A mile of the canal below the tunnel was cut out of rock on the hillside and built to carry 565 cu ft per sec, which was the normal flow designed for. Below this an open-cut canal 13.85 miles long was cut through soil, gravel, and conglomerate. Eleven bridges of stone masonry and concrete were built to carry mud-charged waters over the canal.

Practically all this work was executed by hand methods, employing a force of 5,000 men during the most active months. The only equipment used was the air-compressor with the accompanying drill equipment and a small pumping unit. The stretches of open-cut work and short tunnels in the main canal's one mile of rock section were all done by hand, the workers being brought in from as far as Kalgan, where they had worked on the Peiping-Suiyuan Railway.

In order to bring in the air-compressor a distance of 180 miles from the terminus of the Lung-Hai Railway, a special road had to be built over the last 30 miles. The only other machines more complicated than a wheelbarrow were the 8-hp kerosene engine and the small centrifugal pump used at the dam site on foundation work. All concrete was mixed by hand.

Studies of the King River showed a very low flow for short periods during the months of January and June, with a minimum flow of 250 cu ft per sec. The maximum flow for rare periods has been estimated at 550,000 cu ft per sec. On the main river and most of its branches storage is impractical because of the very heavy silt loads in flood time. Circumstances seemed to warrant the building of tunnels and main canal to carry 565 cu ft (16 cu m) per sec, which is about ten times that provided for in the old system for spring-water feed alone. The watershed above the intake has an area of 16,000 sq miles, approximately, and the runoff is inclined to be very rapid following heavy showers.

TRIPODS WITH PULLEYS WERE INSTALLED NEAR THE EDGES OF CUTS OVER 20 FT IN DEPTH AT WEI PEI

A 60-Lb Basket Is Being Pulled up the Guide Rope by Four Men, of Whom One May Be Seen at Lower Right

In serving about 100,000 acres by this system, which provides a maximum flow of 565 cu ft per sec, an allowance of 4 in. of water per month can be made during much of the growing season, but during short periods in the early summer the entire normal flow of the King River may drop to 40 per cent of the canal's capacity. From October to April the flow of the river is generally greater than the capacity of the main canal, and then the water is practically clear. When turbidity is great, in extreme flood in July and August, the head-gates must be closed for short periods, or sluice gates opened in the upper rock section to prevent undue silting. Mud loads of nearly 50 per cent by weight have been measured during freshets. Under these circumstances a skimming weir was considered of little value. In actual practice, water carrying a mud load up to 20 per cent has been put through the canal system and onto the land, but this is not recommended. However, a 5 per cent load may be carried safely enough.

WEI PEI DIVERSION DAM AND INTAKE STRUCTURES

The diversion dam is a low concrete overflow structure designed to pass a head of 50 ft of flood water. It has a crest length of 215 ft, is 30 ft high in maximum section, and has a top width of 16 ft. Near the intake end, two sluice openings, each 13 ft wide and 10 ft deep, equipped with stop-log timbers, were provided for flushing the mud through. Later, however, the Shensi Conservancy Bureau reduced these openings to one that is nearly 7 ft wide by 7 ft deep.

Three head-gates, 5.75 ft by 4.92 ft, are used to admit the water into the tunnel, which leads under a point of rock to the open-cut main canal below the dam. Hand-operated steel gates are installed in a concrete structure. These gates, which slide against bronze plates, are designed to close the openings tightly, as it is necessary to cut off all flow into the canal system when the silt load is great.

The tunnel section is unlined and has a cross-section of 160 sq ft. Compared with modern work in the United States it is of little significance, but it was pioneer work of its kind in Shensi. In the mile of open-cut main canal in rock immediately beyond the tunnel, 26,000 cu yd of rock was removed by hand, drilling and blasting being done with local black powder.

Where a cut of 70 ft was required in the foothill section, side slopes of 10 on 1 were used down to berms 6 ft in width, 10 ft above the canal bed. The canal has a bottom width of 20 ft with side slopes of 1 on 1 up to the berm. Later the upper side slopes were flattened to 5 on 1 where the soil was not pure loess and sliding had started. The longitudinal slope of the bed was 1 to 2,133. The earthwork in this earth section totaled 1,000,000 cu yd.

The method used for moving this material from the deep cut by hand may be of interest. For the first 20 ft of depth, all the earth was carried out in baskets suspended from the native carrying-pole, borne on the right shoulder of the laborer, the total load per trip in the two baskets being from 100 to 125 lb. This load is carried up a sloping path or a set of steps cut in the earth parallel

THIS 215-FT CONCRETE FLUME ON THE LO HO PROJECT COST ONLY $12,000 IN U. S. CURRENCY

to the edge of the main cutting. When depths exceed 20 ft, tripods with pulleys are installed on top of the bank, near the edge of the cut, and a guide rope is anchored in the canal excavation. A basket carrying a 60-lb load is then hooked over the guide rope and hauled up by another rope running over the pulley on the tripod above, the power being furnished by four men pulling on the other end of the rope. This is an old Shensi device for cleaning canals in deep cuts.

General View Showing Side Slopes and Berms of Canal

THESE Laborers Carry 100 to 125 Lb Each Trip up the Incline

EARTH WAS CARRIED OUT IN BASKETS FROM CUTS LESS THAN 20 FT IN DEPTH ON THE MAIN WEI HO CANAL

In recent years, ordinary labor in this part of Shensi has been paid from 8 to 10 cents in U. S. currency per day of 10 working hours. This rate has been increased somewhat in the past two years. On the Wei Pei job average excavation costs, including deep cutting to a depth of 70 ft, were 6 cents per cu yd in U. S. currency. Rock workers, carpenters, and stone masons average about 20 cents in U. S. currency per day. Since large numbers of day laborers are always difficult to handle efficiently, both rock and earth excavation is let out on a unit basis to gangs of 30 to 50 men.

The Shensi Conservancy Bureau has made numerous improvements and extensions since the work was begun late in 1930, so that the project now represents an expenditure of $500,000 in U. S. currency. To China this is a great sum to put into one irrigation system. The system functions well for 100,000 acres of good farm land, which has tripled in value since the new work was initiated. Wheat and cotton are the staple crops, and various other grains are also grown.

TUNNELS AND AQUEDUCTS REQUIRED ON THE LO HO

Results from the modernized Wei Pei project were so satisfactory that the Shensi Provincial Government began surveys for other nearby projects. In 1933 studies were made along the Lo Ho, a river rising in north-central Shensi, and flowing southeast into the Yellow River just above the mouth of the Wei. This entire work was under the direction of local Chinese engineers, and both provincial and national governments participated in the financing. Construction began early in 1934 and will be completed in the summer of 1937.

TYPICAL DROP ON LO HO PROJECT BELOW A REGULATING GATE

This project, similar to the Wei Pei system, takes the ordinary flow of the river whose adjacent lands it will irrigate. The Lo Ho is tapped in a gorge where a good rock foundation permitted the construction of a masonry dam. The dam diverts flow into tunnels and expensive aqueducts, which extend through rough country before reaching the plains to be served. The tunneling problems were very difficult, on account of the necessity for advancing the headings against running mud without the use of metal shields. The tunnels, lined throughout with cut-limestone masonry, have a total length of 16,000 ft, and the two reinforced aqueducts together, about 650 ft.

In times of heavy rains the Lo Ho has a mud content similar to that of the Wei Ho. Its watershed, barren of trees, has an area of nearly 10,000 sq miles. At normal times the flow of this river is comparatively clear, the average discharge being somewhat less than 500 cu ft per sec. The minimum flow is about 180 cu ft per sec, and for design an extreme maximum of 125,000 cu ft per sec was assumed. The flood of 1935 showed a maximum silt content of 50 per cent by weight at the intake, while a sample taken in 1934 gave as high as 63 per cent solids by weight.

This canal system has a total length of 13.2 miles for the main canal and 48.9 miles for the several branch canals and main laterals below the last tunnel. All necessary structures have been built of stone and concrete, including regulator, waste-gates, bridges, and drops. The two high aqueducts, however, are the most picturesque appurtenances of the system and evidence quite as much skill in construction as the arch masonry dam. This dam has a height of 53 ft, a crest length of 443 ft, a crown width of 16 ft, and a bottom width of 69 ft.

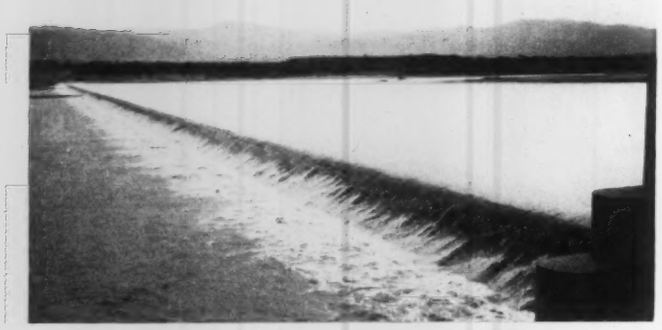
Approximately 80,000 acres of grain and cotton land along the lower Lo Ho will be served by the project. The total cost will be a little over $500,000 in U. S. currency and will be gradually paid for by moderate water rates. Its first real test will come in 1938.

WEI HO SYSTEM INDICATES CONSTRUCTION PROGRESS

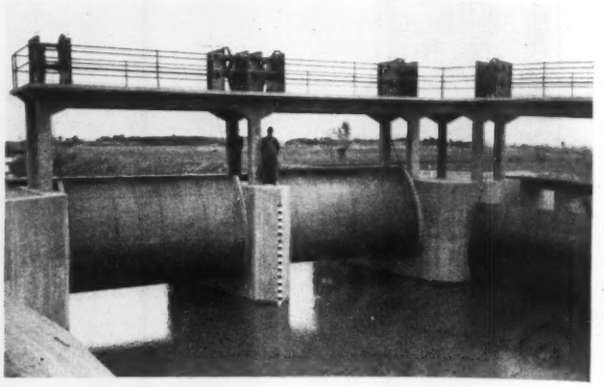
By far the largest river flowing out of Shensi Province is the Wei Ho, which contributes to the Yellow River

the greatest mud load of all the latter's tributaries. The Wei, which rises in Kansu Province, is an important stream even before the King Ho empties into it 50 miles above its mouth.

The Wei Ho project was dedicated by the Shensi Conservancy Bureau after completion of the first stage at the close of 1936. This project will irrigate approximately 120,000 acres on the north bank of the Wei. In the past this land has produced but one crop a year, and because of extreme drought has had complete crop failures once or twice in every decade. With irrigation it is hoped to grow two crops annually as a rule. Like the Wei Pei region, it is adapted to the growing of cotton and grains such as wheat and millet.



THE DIVERSION DAM FOR THE WEI HO PROJECT IS 1,640 FT LONG AND 10.5 FT HIGH



RADIAL GATE STRUCTURE FOR DIVERSION OF FLOW ON THE WEI HO PROJECT

Diversion into this canal system is made at a point nearly 70 miles west of Sian by means of a low overflow dam, 1,640 ft wide and 10.5 ft high above the clay-gravel stream bed. This dam is of concrete with ashlar facing and with two rows of interlocking steel sheet-piling as a protection against percolation. It has a crown width of 6.5 ft and a base width of 26 ft. The depth of flow over the dam should never exceed 12 ft. The apron of the dam is made of cubical wire cages 3.3 ft on each edge and filled with rubble. The lower end of this wall is protected by a concrete wall 3.3 ft thick.

The regulator structure, located immediately above the dam, has six openings, each 5.7 ft wide by 6.5 ft high at the head of the main canal. This structure and all drops, bridges, and the one aqueduct are built of concrete. Combined with the regulator or head-gate structure are sluice gates to wash through mud deposits, for the Wei has a heavy silt load comparable to that found in the King or the Lo.

The main canal is 25 miles long. There are no tunnels, and most of the excavation is in cut of moderate depth. The one aqueduct required for crossing a small stream is 236 ft long. The drops and bridges are of standard design and up to date. Altogether this is the best-built irrigation project yet constructed in China from the standpoint of structures. It represents the progress that has been made in the past five years in this region and the willingness of the provincial government to help finance engineering work in an ample way. Moreover, the farmers are convinced that they will gain through irrigation more than they will be assessed in water rates.

OTHER IRRIGATION PROJECTS

Just upstream and on the opposite bank of the river from the Wei Ho project, a small tributary is about to be tapped to feed another small canal system which will irrigate 30,000 acres of Wei Valley land. The cost of this project, the Mei Hwei, is estimated at $150,000 in U. S. currency. When it is completed, most of the land that can be irrigated by direct diversion from the Wei, King, and Lo rivers will be served. Other lands in this central Shensi territory can only be irrigated by more expensive methods.

In Shansi Province, however, there is much that can be done to extend the areas of irrigated lands along the Fen Ho, the chief river. Three small pumping stations have already been built on the lower Fen Ho where the lift will not exceed 30 ft. Also, in the main Taiyuan plain, the Fen Ho diversion works have been improved somewhat by the construction of two masonry dams with many gates to pass flood waters. But there is need for storage of the winter flow. Although comparatively free from silt, this flow is now wasted to a large degree.

Studies made in 1933 and 1934 by the writer were the basis of a printed report to the Governor of Shansi on this problem of Fen Ho conservancy. The total estimated cost of the improvements deemed necessary for flood protection and water conservation on that river amounted to approximately $4,000,000 in U. S. currency. This is one of the projects that await capital for their execution. It is the next logical water conservancy undertaking for North China, since the Shensi work is now nearly completed. Though returns on the investment may be slower from such a project than from a railway built through densely settled country, it is equally sound where government functions justly and is stable.

REGULATING GATES NEAR THE INTAKE OF THE WEI HO PROJECT

Lumber Production in the United States

Including a Description of Modern Methods of Logging, Sawing, and Grading

By Nelson Courtlandt Brown

Professor of Forest Utilization, New York State College of Forestry, at Syracuse University, Syracuse, N.Y.

IN proportion to its weight, wood is still the strongest material available to man. As it is also the material most widely used in building construction, a knowledge of its characteristics and methods of production is important. The peak of lumber production in the United States was reached in 1909, but over 20,000,000,000 board feet are still marketed annually—an amount sufficient to build each year 1,300,000 frame dwellings of a size suitable for the average family. Making no allowance for increase in growth, the saw-timber available in the United States today is sufficient for another 50 years' consumption, at 1925–1929 production rates. On the other hand, says Mr. Brown, if present stands and future growth are properly managed and protected from fire, insects, and disease, the country will be able to produce now and always not only all the lumber required for its own varied uses, but also sufficient additional to develop a large and profitable export trade.

THE lumber industry is the oldest and one of the most typical in the United States. The first sawmill, driven by wind, was erected on Manhattan Island in 1623. The industry flourished for many years in Maine, and then moved to New York and Pennsylvania. About 1890 it expanded to Michigan, and later shifted to the South, where it reached its peak in 1907–1916. From the South it moved to the north Pacific coast, the peak here being reached in 1926.

Some of the finest, most valuable, and most useful timber to be found anywhere in the world has thus been marketed to meet the demand for a construction material and for the four thousand other uses to which lumber may be put. White pine, probably the most useful American tree, continued as the most important form of lumber down to 1900. Since that time the principal production has been in southern pine, and now it is in Douglas fir and southern pine. Normally, about one million men are directly employed in the production of lumber, and perhaps ten million men receive, directly or indirectly, their bread and butter from this industry.

The peak of lumber production in the United States was reached in 1909, with about 46 billion board feet (fbm). The recent normal annual production (ending in 1929) was about 38 billion fbm. During 1932, production fell to about 10 billion, but since that time it has advanced to over 20 billion fbm. There are now about 30,000 sawmills engaged in lumber production. The world's lumber-producing center is at Longview, Wash., where there are two huge sawmills and pulp mills as well as other wood-using industries.

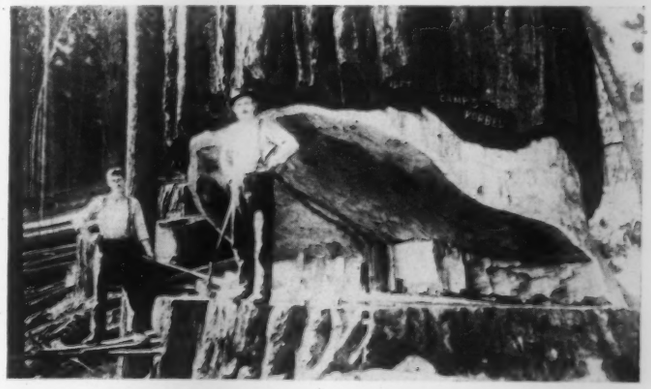
At present the available saw-timber in the United States totals more than $1\frac{1}{2}$ trillion fbm. Not considering increase in growth, this amount is sufficient at the normal rate of cutting (1925–1929) to last for more than 50 years. But, although abundant in quantity, saw-timber is not well distributed throughout the country. Contrary to public opinion commonly prevailing with regard to a possible timber famine, I believe that with proper fire protection, prevention of damage by insects and disease, and improvement in forestry practices, this country will be able to produce all the lumber required for the various uses of wood, as well as for the development of a large export trade.

Woods are broadly classified as hardwoods and softwoods. Hardwoods come from the broad-leaved or deciduous trees, which generally produce the harder woods. Softwoods come from the conifers, or evergreens, which generally produce softer woods. However, this classification is not, strictly speaking, a measure of hardness, as some softwoods are harder than some hardwoods.

About 89 per cent of our standing timber consists of softwoods (such as pines, spruces, firs, cedars, redwood, and cypress), and about 11 per cent of hardwoods (such as oaks, maples, red gum, yellow poplar, ash, hickory, birch, and beech). More than 79 per cent of the remaining saw-timber is found in the three Pacific coast states (the principal species being Douglas fir, ponderosa pine, western hemlock, Sitka spruce, western red cedar, sugar pine, and redwood), despite the fact that the South has the largest area devoted to forests, namely, 39 per cent of the total forest area of the country. There will always be an ample supply of lumber and timbers of southern pine to meet the requirements of construction and industry.

In order of importance, the principal species of lumber produced at the present time are southern pine, Douglas fir, ponderosa pine, oak, white pine (including eastern, sugar, and Idaho white pines), hemlock (including both eastern and western varieties), red gum, maple, cypress, redwood, spruce, tupelo gum, poplar, and birch. The first two of these species contribute about 60 per cent of all lumber produced, and the first three about 75 per cent. Hardwoods comprise 14 per cent, and softwoods 86 per cent of all lumber cut.

Advantages of the use of wood may be summarized as follows: (1) In proportion to its weight, wood is the strongest known material. (2) It is the most workable material. (3) It is an excellent non-conductor of heat.



A Man's-Size Job—Felling a 16-Ft California Redwood
The Axman at the Left Is Standing on a Felling Platform

TYPICAL LANDING OF WESTERN MONTANA PONDEROSA PINE
These Logs Are Decked at the Head of a Chute Awaiting Transportation to the Railroad Spur in the Lower Valley

(4) It is comparatively inexpensive, and when treated with creosote or other preservatives, is very durable. (5) It is abundantly available in so many different varieties and forms. (6) It is susceptible of widely varying kinds of treatment, as illustrated by flooring, furniture, and interior finish.

Washington and Oregon produce about 38 per cent of the total lumber output and are the source of 96 per cent of all the Douglas fir. California produces largely ponderosa pine, together with considerable quantities of redwood and sugar pine. Alabama and Arkansas produce principally southern pine but are also important sources of hardwoods. All Southern states from Virginia to Texas, inclusive, produce southern pine. Idaho produces largely Idaho white pine and ponderosa pine. The principal producing centers of hardwoods are states in the lower Mississippi Valley, including particularly Tennessee, Louisiana, Mississippi, and Arkansas.

MODERN IMPROVEMENTS IN LOGGING

Cutting of the more accessible forests has forced the lumberman to adopt advanced logging methods. After the trees are felled in the woods, they must be "bucked up" into log lengths for various sizes of timbers, planks, and boards. Recently, saws driven by gasoline engines have been introduced both for felling trees and for bucking the fallen trunks into log lengths. Instead of horses and mules, tractors are generally used to skid logs to landings, log decks, skidways, and log dumps. The enormous size of the Pacific Coast timber requires the use of power logging and tractors.

The methods used in transporting logs have also changed; the old rafting and stream-driving methods used in Maine, Michigan, and the upper tributaries of the Mississippi River have given place to the logging railroad and, still more recently, to the motor truck. There are 300 separate logging railroads in the state of Washington, but the motor truck is furnishing flexible and economical transportation both there and elsewhere.

Great improvements have also marked life in the logging camps. Today one finds that separate beds and mattresses, recreation and reading rooms, and many other facilities have replaced the old-fashioned straw bunks and the central stove in the formerly ill-smelling and sometimes verminous log huts. Today the men generally work only 8 to 9 hours a day and are well paid.

The stories of Paul Bunyan and his superhuman feats of logging are still repeated in the woods. It was Paul and Babe, his big blue ox, who accomplished historic feats in the early days of logging "cork white pine" in the Lake states. But it is easy to believe, when watching some of the huge Douglas fir and redwood trees, 5 ft or more in diameter cut in lengths up to 70 ft or over, being brought up by enormous skidders in the Pacific woods, that modern activities rival even Bunyan's feats.

One of the outstanding recent developments in the industry has been selective logging—that is, the cutting of only the largest trees, which will yield a profit, and leaving the residual timber stand to grow, protected from fire. This is the forerunner of better silvicultural practices looking towards sustained production. Groups of American lumbermen have brought in some new European methods which have already resulted in better logging and manufacturing, and more permanent forest management.

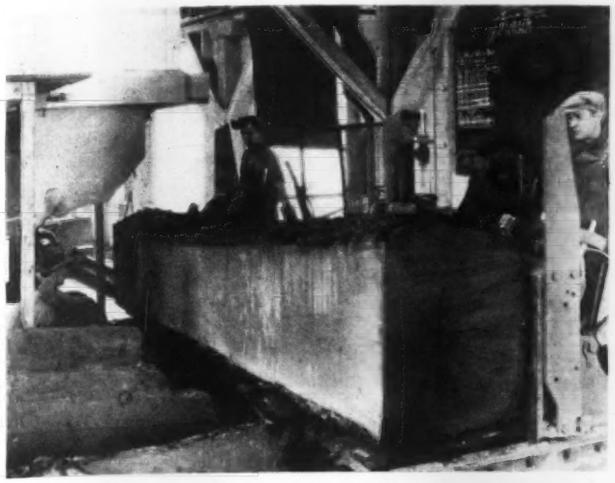
Enormous development has also taken place during the past century in the facilities for lumber manufacture. After the early crude water-driven saws came the circular saw. Then followed the band saw—a wide, thin band of steel traveling at great speeds around upper and lower wheels, between which the logs are passed. Although a large part of the northwestern and southern lumber is now cut in large band sawmills, there is a definite trend towards the use of small ones. But the big mills still produce the best product, with more uniform and dependable grades, and more accurate sizes. Furthermore, lumber from large mills is generally seasoned and conditioned very much better.

FOLLOWING A LOG THROUGH THE MILL

From the railroad car or motor truck the log is generally unloaded into a large log pond for storage purposes. When sawing is begun the log is elevated to the second floor of the sawmill by a continuous chain known as a jack ladder, bull chain, or jacker chain. As a log enters the sawmill it is usually cross-cut from long lengths to 10-ft to 16-ft lengths, or longer if desired. A steam "kicker" then forces it to the log deck, where a "log stop and loader" holds it back until needed. Then a most interesting device, known as a "steam nigger" or log turner, pushes the log onto the carriage and turns it to the proper position. The saw carriage holds the log against the knees and head blocks by a system of mechanically operated "dogs" (sharp steel teeth) controlled by a setter and one or two "doggers," who ride on the carriage.

A LOG-STORAGE POND AT A SOUTHERN HARDWOOD SAWMILL

The carriage conveys the log through the head saw, which may be either a single- or a double-cutting band saw. These saws travel at speeds of about 9,000 ft per minute and make successive cuttings of lumber from the log. The sawyer who regulates the movement of the carriage and log turner and signals the setter for



HEAD-SAWING AN OAK LOG IN TENNESSEE

The Sawyer Appears in His Box on the Left, with the Band Saw at His Left. The Log Is Mounted on the Carriage, Which Is Controlled by the Setter (Second from Right) and Two Doggers

the next saw cut is the most important and best-paid man in the mill, as he must be able to produce the best grades in all cases. Each log presents a different problem in size, taper, defects, grades, and other properties.

From the head saw, the lumber is passed by a system of live rolls and conveyors to the edger, a machine with circular rip saws regulated for various widths. The edger saws cut parallel edges, removing the bark, knots, or other defects, or ripping wide boards into two or more. Then the lumber is automatically conveyed to the trimmer cross-cut saws, which cut off the boards at exact lengths. Both the edgerman and the trimmerman must thoroughly understand grades in order to eliminate defects and advance the grade, from a $30 to a $60 quality, for instance. From the trimmer saws the lumber passes to the sorting table, where it is graded according to its freedom from knots, checks, pitch pockets, and other defects; then it is sorted for piling. A separate pile is made for each grade and size.

In recent years much progress has been made in kiln-drying lumber. About half the weight of wood is water, which must be eliminated under proper humidity and temperature control, as lumber is being purchased more and more on the basis of moisture content. Timbers (that is, those 6 by 6 in. and larger) are never kiln-dried, edged, or trimmed, but go directly from the head saw to the loading docks. In the case of hardwoods, lumber is generally air-seasoned from four to ten months or more and then kiln-dried for fabrication or final use. Many modern mills are putting green lumber from the sawmill directly into huge dry kilns. Lumber is better manufactured, graded, seasoned, and handled today than it ever was before, and many sawmills have plants in connection with them where treated lumber may be secured.

In some of the larger sawmills there are various devices for increasing output, such as horizontal and vertical band resaws which rip thick planks into two boards. For example, the head saw may cut $2^3/_8$-in. pieces. The resaws then cut each piece in two, producing two 1-in. boards. Then there are gang saws which make a large number of cuts synchronously from cants or outer portions of logs. Quarter-sawed flooring is made from Douglas fir and southern pine in this way.

Some mills specialize in making large or long timbers, and there are plants in the Northwest which saw logs up to 60 ft or more in length and produce timbers up to 30 by 40 in. or larger in cross-section. Sawmills generally turn out lumber from 10 to 16 ft long and timbers up to 24 or 30 ft long, as there is very little demand for timbers longer than 30 ft. There are two classes of mills—so-called board mills and timber mills. Ponderosa, sugar, Idaho white, and eastern white pines, as well as cypress and hardwoods, are generally sawed into boards and practically never into studs, planks, joists, or timbers; whereas Douglas fir, southern pine, redwood, and western hemlock are cut into both. Owing to the differences in weight, hardness, and strength, between longleaf and shortleaf pine, the former species is used for timbers and flooring while the wide-ringed, lighter-weight shortleaf pine is used for sheathing, siding, subflooring, concrete forms, and crating materials, as well as for timbers and flooring.

GRADING AND TRADE-MARKING

An outstanding development in the lumber industry has been the marking of the species and grade on each piece of lumber. Responsible mills encourage the grade- and trade-marking of their product, which assures the buyer he will have the proper grade. It also prevents grade substitution, a practice which has unfairly injured the lumber business. Marking is generally done by rubber stamps either on the end or on the face near the end of each board or timber, and usually indicates the species, grade, and the manufacturers' association. Inspection certificates insuring grades, sizes, and specifications to the ultimate buyer, are also issued and recognized by some of the lumber manufacturers' associations. Certificates issued by some of these associations have attained an enviable reputation for accuracy and dependability.

Unfortunately lumber other than timbers is not graded in a way that can be easily understood by the public, by writers of specifications for construction projects, or even by the buyers. In hardwoods, for instance, the best grades in order of value and freedom from defects are: (1) Firsts and seconds, (2) selects, (3) No. 1 common, (4) No. 2 common, (5) No. 3 common, (6) No. 4 common. In softwoods, the best grade of boards is known as "B" and better. Then there are "C" and "D" selects among the white and ponderosa pines,

PONDEROSA PINE IN NORTHERN CALIFORNIA

A Tractor Equipped with Arch and Hoist Has Skidded These Logs to the Railroad Landing, Where a Log Loader Lifts Them Onto the Flat Cars

followed by No. 1 common, No. 2 common, No. 3 common, and No. 4 common, which apply to all softwoods. The grading given applies for the general classification of lumber, but different grades are commonly in use for flooring, factory or shop uses, and for recutting or other specialized purposes.

Timbers are generally classified in one or two grades. The merchantable grade, which insures the strength and structural qualities of the piece, is generally all that is required, although a density rule which insures a minimum number of growth rings per inch has been introduced and used to a limited extent. For timbers which must resist certain stresses, the density rule may be very important. Grading rules which represent considerable experience and study have been issued by all the important lumber-manufacturers' associations, and are readily available to all interested parties.

EDGERS AND TRIMMERS IN A SOUTHERN SAWMILL

Two Edgers Appear on Left and Right of Center. The Trimmer Is in the Extreme Right Background. Live and Dead Rolls, and Transfer and Conveyor Chains Furnish the Transportation

LUMBER FROM MILL TO MARKET

As the accessible virgin-timber resources of the country were depleted, it became necessary to cut timber in remote locations and to transport the final product for considerable distances to the great consuming markets. In 1914 the average rail haul for lumber from mill to market was 360 miles; whereas in 1937 it was 820 miles (estimated). Lumber coming to the Northeast travels an average rail distance of 840 miles, to Chicago and to the Lake states 910 miles, and to the central states 1,515 miles. Since the opening of the Panama Canal, lumber has moved from the Northwest to the Atlantic seaboard largely by vessel, increasing from a few million board feet in 1920 to about two billion board feet in 1928. This large volume moves to the East from the Far West by boat because the water rate of $12 to $14 per thousand board feet is far less expensive than the rate of 78 cents per hundred pounds for rail transportation from Pacific Coast markets to Buffalo, Pittsburgh, and points east.

Los Angeles probably leads the world in volume of lumber received and handled by water. Of the large amount of Douglas fir produced, about 34 per cent is moved to the North Atlantic states (largely by water), 30 per cent into the Middle West (by rail), and 23 per cent to California, while 13 per cent is consumed within the producing territory. Southern pine moves to the Northeast both by rail and water. New York leads all the states in lumber consumption, followed by California, Illinois, Michigan, Pennsylvania, and Ohio in that order. New England is also an important center for the use of lumber.

Stumpage (value of standing timber) in the far-away hills is generally priced from about $2 to $5 per thousand board feet, and lumber is still relatively cheap at the sawmills. Many species, sizes, and grades could be purchased as cheaply in 1932 as in 1905. Vast labor charges are incurred in felling trees, bucking and skidding logs, transporting them to sawmills, sawing them into lumber, conditioning the product by means of dry kilns, and transporting it to its destination. Thus lumber may be worth only $3 in standing timber, $12 when logged, $22 when sawed and conditioned, and $35 to $50 or more when delivered in Chicago or at the principal cities of the Atlantic seaboard. If it is retailed, still more handling charges and overhead will be added.

SUSTAINED-YIELD PRINCIPLES IN THE LUMBER INDUSTRY

In the past, there have been "cut-and-get-out" and the "boom-and-bust" days in the lumber industry just as in the handling of other resources such as agricultural soils, mines, oil, and water. But the principle of sustained-yield forest management is penetrating the lumber industry. This modern development has been widespread in the territory of southern pine as well as in that of Douglas fir, Sitka spruce, redwood, Idaho white pine, ponderosa pine, and sugar pine. Among some of the outstanding examples of permanent community centers producing large volumes of lumber and forest products are Laurel, Miss.; Chapman and Brewton, Ala.; Bogalusa and Urania, La.; Crossett, Ark.; Aberdeen, Longview, Hoquiam, Everett, and Olympia, Wash.; Bend and Portland, Ore.; Cloquet, Minn.; and Marinette, Wis.

Better scientific information regarding lumber and its uses has been made available as a result of extensive research studies by the U. S. Forest Products Laboratory at Madison, Wis. The Division of Forest Products and the Bureau of Standards of the U. S. Department of Commerce have also been exceedingly helpful.

Among the outstanding recent trends in the manufacture and conversion of lumber have been the following:

1. Introduction of the so-called Swedish gang saw on the west coast to convert smaller logs into 2-in. and 1-in. boards.
2. Introduction of the portable band saw in the South. This saw cuts a kerf of approximately $^5/_{32}$ in. instead of the usual $^1/_4$-in. cut by the circular saw. (Approximately 10 per cent of all wood that goes to sawmills is lost in the form of sawdust.)
3. Increased production from small sawmills. These have generally produced very inaccurately sawn and poorly seasoned lumber, but with the provision of concentration yards and with proper facilities for kiln-drying and planing, some excellent lumber is now turned out.
4. Increasing use of trade- and grade-marked lumber to eliminate grade substitution.
5. Better merchandising methods, and manufacture at the mills to suit a more exacting demand for sizes and grades.
6. Better seasoning of the finished product through improved kiln-drying processes.
7. The use of connectors in heavy construction work to insure greater strength and rigidity, in such structures as oil derricks and radio towers.

Settlement Stresses Found with a Model

Stresses in a Statically Indeterminate Structure Are Easily Determined by Use of a Wire Model

By Anders Bull

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Assistant Engineer, Board of Transportation, New York, N.Y.

After describing some recent improvements in the technique of wire-model analysis, Mr. Bull tells how the stresses produced by settlement in a multiple-frame structure were determined by means of loaded wire models. In the case referred to, mathematical analysis was found too extensive and cumbersome for practical use, and methods of model analysis based on Maxwell's law of reciprocal deflections were not suitable. The method used avoids both these difficulties and is at the same time highly accurate, as demonstrated by comparing results of tests on a simplified model with the corresponding values determined mathematically. Further tests were later made on a second model, conforming more closely to the prototype and therefore giving more conclusive information. These indicated that the simplification adopted for the first model gave unsafe results for settlement stresses, although safe when dealing with external loads. A more detailed paper by Mr. Bull on the same subject has been filed in the Engineering Societies Library.

SOME years ago, the writer suggested the use of brass wire in making models for the mechanical analysis of problems involving statically indeterminate stresses (*Engineering News-Record*, December 9, 1927. The formula for G on page 921, line 4, right, should read $G = \frac{1}{2}F \times$ cotan V). That article had reference to structures with fixed supports in which the stresses are due to external loads. In dealing with problems of that class, Maxwell's theorem, as adapted by G. E. Beggs, M. Am. Soc. C.E., is used to advantage for finding the unknown reactions. The solution defines the relations between forces only, and is arrived at by linear measurements on the deflected model. Since the relations are fully determined by the dimensions of the structure, the reactions remain the same whether the latter is stiff or flexible.

This is not true of another class of problems—those in which the stresses are due to settlement, temperature changes, or elastic yielding of the supports. In this case, the stiffer the structure the higher the stresses; the modulus of elasticity enters the problem, making it necessary to determine the relations between forces and deflections. Wire models, because of their ruggedness and flexibility, lend themselves well to this type of work, as will be illustrated. Mention will first be made, however, of some recent improvements in the methods used.

CALIBRATING THE WIRES

The flexibility of the kind of brass wires used is not a function of their gage diameter only, as the modulus of elasticity is not always the same. Variations of as much as 10 per cent have been observed, and calibration is necessary to eliminate any source of error on that account. This is done by measuring the deflection D produced by a force P, applied at a distance L from a cantilever support. According to the formula, $D = \frac{PL^3}{3EI}$, the inverse deflection value is proportional to the product of the modulus of elasticity and the moment of inertia. It is thus strictly comparable with the moment of inertia of structural members whose modulus of elasticity is not subject to variation.

The arrangement used is shown in Fig. 1. The wire is deflected by means of a weight attached to a string which runs over a ball-bearing pulley, the deflection being read off on a paper scale glued to a mirror so as to avoid parallax. In order to keep deflections within a suitable range, lighter weights are used for the thinner wires, the deflections being reduced to a uniform denomination by multiplying by the ratio of the lighter weight to the heavier one.

Each wire thus calibrated is tagged, giving its inverse deflection value in any convenient unit, bearing in mind that relative values only are needed. The logarithms of these values are then recorded for all the wires, as shown in Fig. 2. The logarithms of the moments of inertia of the members in the structure to be investigated are similarly recorded on a strip of paper. By sliding this strip along the record of the wires, the position in which the two sets of lines most closely coincide is easily located, thus indicating the wires to be used in the model. While the procedure described may seem needlessly elaborate, its advantages will be appreciated when the structure is composed of members of many different sizes.

For eliminating parallax in marking off model deflections, a sighting device of the type shown in Fig. 3 is used. This consists of a piece of mailing tube mounted at right angles to a weighted base and having a watchmaker's

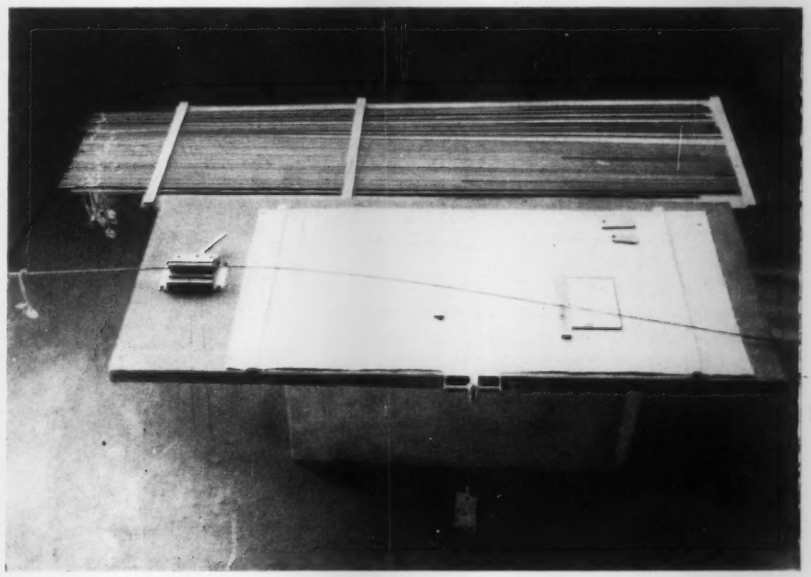


Fig. 1. Wire Being Calibrated, Showing Calibration Clamp at Left and Scale on Mirror at Right

lens inserted at its lower end. In Figs. 1 and 3 may also be seen the pulleys. The frames each consist of a brass angle holding a rod which runs through the hub of the pulley so as to permit lateral adjustment. The frame is

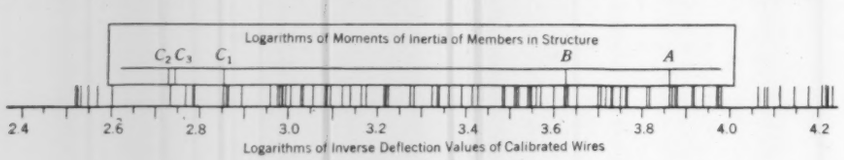


FIG. 2. PAPER DEVICE FOR SELECTING MOST SUITABLE WIRE SIZES

fastened to the edge of the board by means of a steel point, and a hook at the end of the string serves for attaching it to the wire or model.

A PRACTICAL SETTLEMENT PROBLEM SOLVED

An interesting problem in connection with the Corona Yard car-shed of the Interborough Rapid Transit Company was solved by wire-model analysis. This structure, which was erected in 1927 on clayey ground, subsequently showed signs of distress on account of vertical and lateral movements of the column foundations, making an analysis of the resulting stresses desirable. The structure consists essentially of 24 bents supporting a saw-tooth roof. Each bent is composed of two roof beams, *A* and *B*, (Fig. 4) and three columns, *C*. The upper corners of the columns are stiffened by the knee braces *K*, and their bases are anchored to concrete footings *F*, which rest on piles.

Measurements made in 1932 indicated vertical movements of the footings ranging from 6 to 24 in., combined with lateral movements of from zero to 5 1/2 in. in the plane of the bents and from zero to 3 1/2 in. at right angles. Of the lateral movements, only those in the plane of the bents need be considered. No doubt there were also some angular movements, but owing to the difficulty of measuring them no data have been available.

The structure is built up of members having five different moments of inertia. The corresponding wires for the model were selected in the manner explained, and the model was assembled over a center-line diagram of the structure, drawn to a scale of 1 in. = 2 ft 6 in. (30-scale).

For the purpose of demonstrating the accuracy of wire-model analysis, a model [Fig. 5(*a*)] was built on the simplified assumptions usually made for a mathematical treatment. The knee braces were disregarded, except in so far as they served to make the structure rigid at the corners. Moreover, since the elastic behavior of the structure is principally governed by the comparatively slender columns, the center line of the roof beams was assumed to be lowered by half the depth of the beams in order not to increase the column lengths. The model shown in Fig. 5(*b*), more closely corresponding to the prototype, was constructed later and will be described hereinafter.

Rigidity at the corners was attained by soldering the wire ends to the plates *p*. At their lower ends the column wires were soldered to crosses made of 1/4-in. strips, *s*, of 26-gage brass, bent slightly so that they would not rub against the wires. Holes *h*, of 0.04-in. diameter and centered on lines drawn horizontally and vertically through the points representing the theoretical column bases, were punched in the strips at the ends and crossing points. The strips were nailed to the board with brads which fitted the holes, and 1/4-in. diameter brass balls were inserted between the corner plates and the paper to reduce friction.

Since the column bases were fixed, the least number of unknown quantities to be solved for was six. These were the horizontal, vertical, and rotational reactions at two of the bases, the reactions at the third base being found by equilibrium requirements. In this case, however, it was decided to determine the reactions at all three bases independently, as unavoidable inaccuracies in measurements may be cumulative.

The known quantities were the measured displacements of the bases. As stresses are due to relative displacements only, the displacements to be considered were those of two of the bases with respect to the third. Considering the base of column C_3 as fixed, the relative displacement of the other two bases are represented in Fig. 4 by their horizontal and vertical components, *a*, *b*, *c*, and *d*. These components, which will be referred to as "movements," are considered positive in the directions indicated in the figure.

Obviously, any of the nine reactions to be determined may be expressed by the formula,

$$R = r_a a + r_b b + r_c c + r_d d \ldots\ldots \quad [1]$$

where each *r* symbol represents the reaction due to one unit of the respective movement. Its values are obtained from measurements on the model, which is deflected in such a way that only one of the movements is investigated at a time.

Owing to the large deflections used, the model was distorted and as a result its rigidity varied. Errors on this account were avoided by repeating the measurements with the deflecting force reversed and taking the numerical averages of the results.

As the procedure for determining the *r*-constants is similar for each of the four movements, it will be explained in detail for the *b* movement only. The terms "horizontal," "right," and "left" are used to indicate

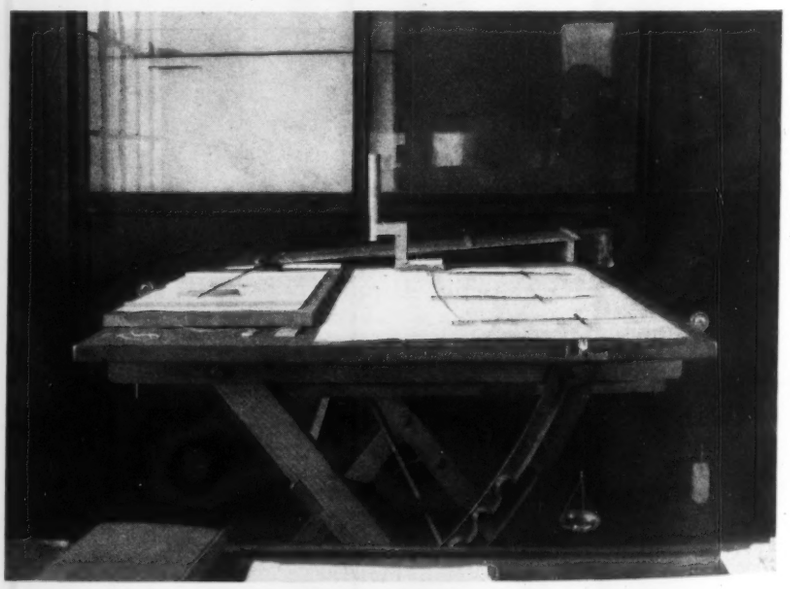


FIG. 3. MODEL BEING DEFLECTED, SHOWING LOADS AND SIGHTING DEVICE FOR ELIMINATING PARALLAX

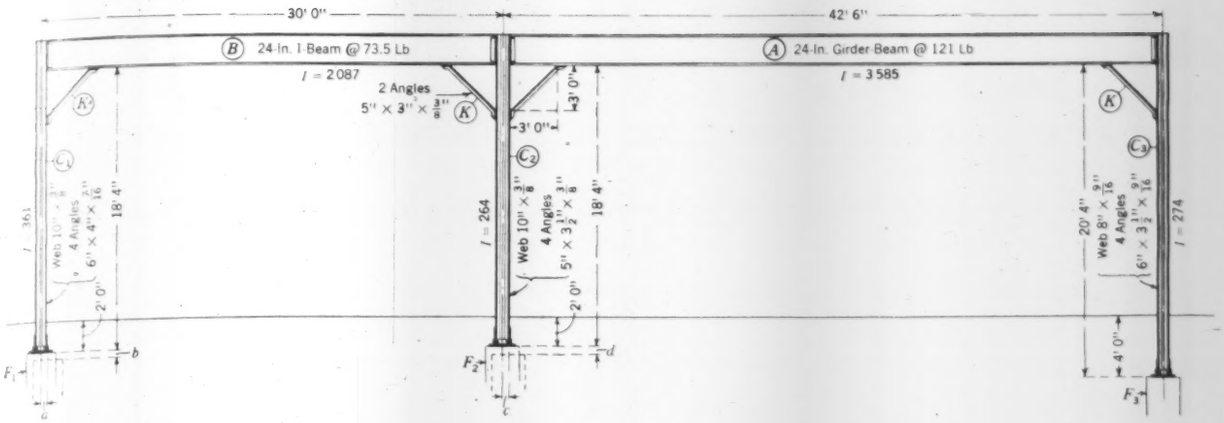


FIG. 4. CORONA YARD CAR-SHED OF THE INTERBOROUGH RAPID TRANSIT COMPANY, CROSS-SECTION SHOWING BENT
Prototype of the Wire Model Used in the Tests

directions parallel to the undeflected roof beams, while the terms "vertical," "down," and "up" are used for directions at right angles thereto. A positive sign is used for reactions that are directed upward or to the left and for moments that cause tension in the top fibers of roof beam *A* (Fig. 4).

APPLYING LOADS TO THE MODEL

After nailing the crosses of the center and right columns to the board, the left column cross was deflected by a vertical force y'_1 (Fig. 6), by inserting the hook into the lower hole of the vertical strip and loading the string with a weight of 100 *g*. Anti-friction balls were used where necessary.

The cross assumed a tilt in deflecting, while the center hole h_1, representing the theoretical base, moved downward and to the right. The tilt and the horizontal component a were eliminated by a horizontal force x'_1, applied by hooking a second string, t_2, carrying a light balance tray, to the vertical strip. The weights in the tray were adjusted and the eccentricity of the force varied by sliding the hook along the strip until both the center hole and the lower hole were again directly over the column center line. The model thus deflected is shown in Fig. 3.

Using the sighting device, the position of the center hole and that of the string t_2 were then marked off on the paper, the displacement D'_b and eccentricity e'_1 measured, and figures affixed giving the forces used. For $y'_1 = -100$, D'_b was found to be $+31.0$ units on the 30-scale, while e'_1 equaled 34.5 and x'_1 equaled $+48.7$, giving for the eccentric moment, $z'_1 = +34.5 \times 48.7 = 1{,}680$.

TABLE I. DATA ON TESTS FOR *b* MOVEMENTS

QUANTITY	FOR POS. *b*	FOR NEG. *b*	AVERAGE	CONSTANT r_b
D_b	+31.0	−37.8	+34.4	.....
q_b	....	....	0.0371	.....
x_1	+48.7	−47.7	+48.2	$h_1 =$ +1.79
e_1	34.5	13.0	.....	.....
y_1	−100	+100	−100	$v_1 =$ −3.71
$z_1 = x_1e_1$	+1,680	−620	+1,150	$m_1 =$ +42.7
x_2	−6.6	+9.8	−8.2	$h_2 =$ −0.304
y_2	+154.5	−164.5	+159.5	$v_2 =$ +5.92
e_2	14.8	11.0	.....	.....
$z_2 = y_2e_2$	−2,285	+1,810	−2,048	$m_2 =$ −75.9
x_3	−42.2	+39.2	−40.7	$h_3 =$ −1.51
y_3	−58.2	+64.9	−61.6	$v_3 =$ −2.28
e_3	80.8	66.2	.....	.....
$z_3 = y_3e_3$	+4,700	−4,300	+4,500	$m_3 =$ +167

Reversing the deflecting force, using the top hole in the strip, the following values were found: For $y''_1 = +100$, $D''_b = -37.8$; $e''_1 = 13.0$; $x''_1 = -47.7$; $z''_1 = -13.0 \times 47.7 = -620$ (dashed lines in Fig. 6).

Denoting the numerical averages by D_b, x_1, y_1, z_1, respectively, and retaining the signs applying to a positive displacement, the results were:

$$D_b = + \frac{31.0 + 37.8}{2} = + 34.4$$

$$x_1 = + \frac{48.7 + 47.7}{2} = + 48.2$$

$$y_1 = - \frac{100 + 100}{2} = - 100$$

$$z_1 = + \frac{1{,}680 + 620}{2} = + 1{,}150$$

DETERMINING CORRESPONDING REACTIONS IN THE STRUCTURE

x_1, y_1, and z_1 are thus the three reactions produced at the left base of the model by a

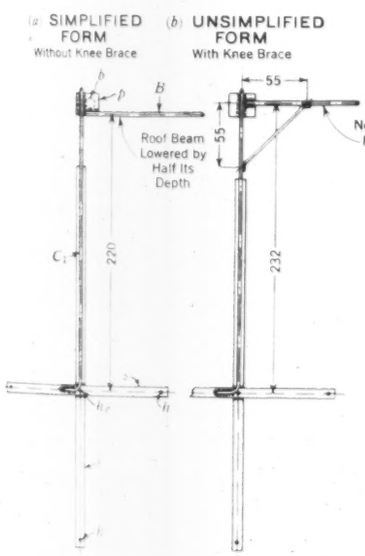


FIG. 5. ARRANGEMENT OF LEFT-HAND COLUMNS OF WIRE MODELS

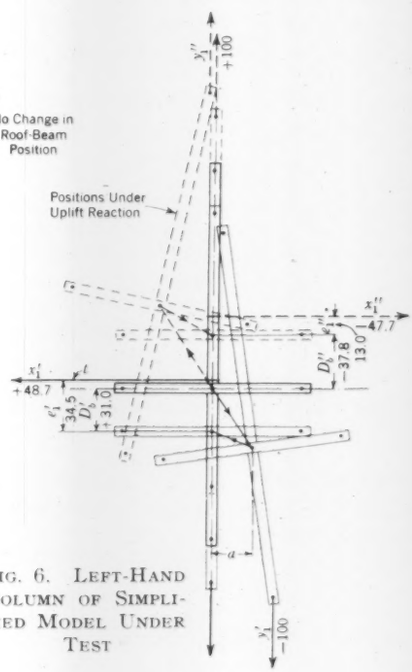


FIG. 6. LEFT-HAND COLUMN OF SIMPLIFIED MODEL UNDER TEST

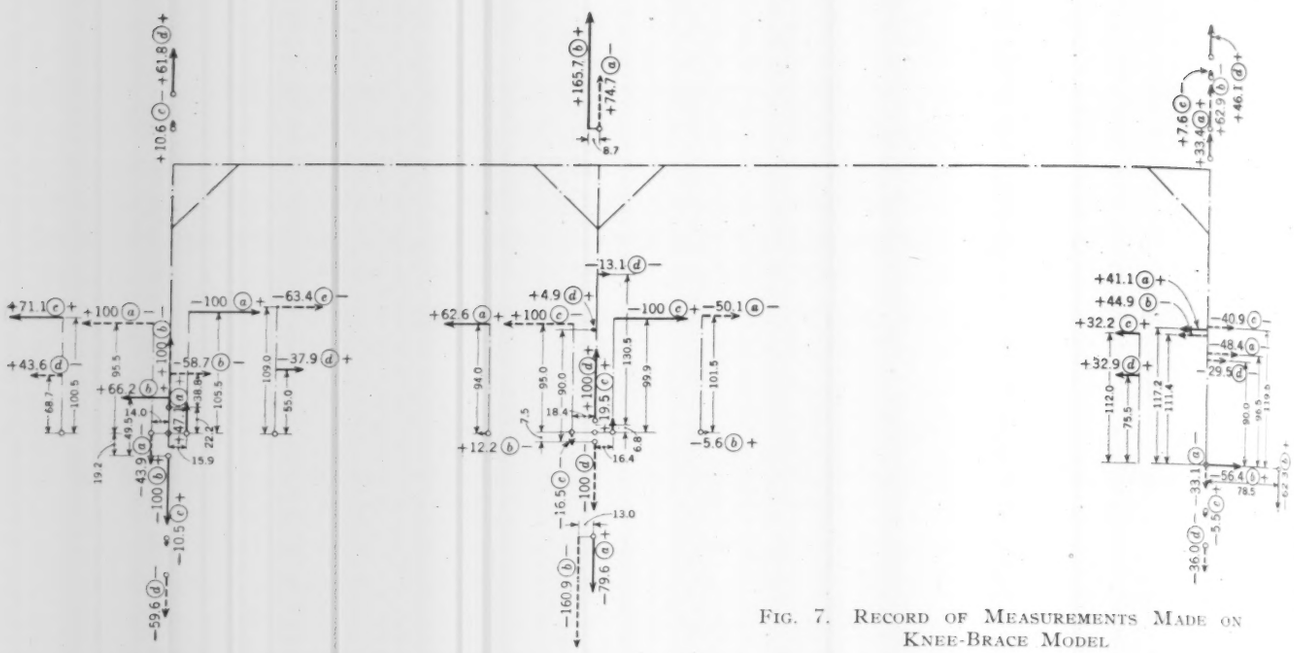


FIG. 7. RECORD OF MEASUREMENTS MADE ON KNEE-BRACE MODEL

b movement of 34.4 units, assuming the rigidity to be the same as for small deflections. For finding the corresponding reactions in the structure it was first necessary to determine the structural equivalent of the force unit used in the model.

This was done by inserting in the calibration clamp a piece of the wire from which roof beam A in the model was cut, and measuring the deflection produced when the 100-g force was applied 360 units (12 in.) from the fixed end. It was found to be 19.1, and the deflection produced by one force unit is therefore 0.191.

Consequently, if an equivalent structural force P were applied 360 in. from the fixed end of a cantilever of the same material and section as roof beam A, the resulting deflection would be 0.191 in.

TABLE II. DATA ON TESTS FOR ALL MOVEMENTS

		LEFT BASE		
$H_1 =$	$-5.77\,a$	$+1.79\,b$	$+3.18\,c$	$-3.23\,d$
	$-5.671\,a$	$+1.851\,b$	$+3.114\,c$	$-3.276\,d$
	$-8.55\,a$	$+3.85\,b$	$+4.94\,c$	$-7.28\,d$
$V_1 =$	$+1.78\,a$	$-3.71\,b$	$-0.312\,c$	$+6.00\,d$
	$+1.842\,a$	$-3.561\,b$	$-0.3030\,c$	$+5.767\,d$
	$+3.89\,a$	$-6.17\,b$	$-0.78\,c$	$+10.84\,d$
$M_1 =$	$-678\,a$	$+42.7\,b$	$+382\,c$	$-201\,d$
	$-673.8\,a$	$+60.01\,b$	$+380.5\,c$	$-203.4\,d$
	$-857\,a$	$+171\,b$	$+516\,c$	$-453\,d$
		CENTER BASE		
$H_2 =$	$+3.23\,a$	$-0.304\,b$	$-4.98\,c$	$+0.515\,d$
	$+3.115\,a$	$-0.3055\,b$	$-4.940\,c$	$+0.5438\,d$
	$+4.82\,a$	$-0.55\,b$	$-7.34\,c$	$+1.61\,d$
$V_2 =$	$-3.33\,a$	$+5.92\,b$	$+0.486\,c$	$-10.30\,d$
	$-3.266\,a$	$+5.775\,b$	$+0.5398\,c$	$-9.753\,d$
	$-6.59\,a$	$+10.07\,b$	$+1.32\,c$	$-17.86\,d$
$M_2 =$	$+364\,a$	$-75.9\,b$	$-563\,c$	$+73.1\,d$
	$+356.3\,a$	$-77.74\,b$	$-567.4\,c$	$+66.79\,d$
	$+477\,a$	$-109\,b$	$-715\,c$	$+192\,d$
		RIGHT BASE		
$H_3 =$	$+2.45\,a$	$-1.51\,b$	$+1.95\,c$	$+2.63\,d$
	$+2.556\,a$	$-1.545\,b$	$+1.826\,c$	$+2.732\,d$
	$+3.82\,a$	$-3.13\,b$	$+2.68\,c$	$+5.57\,d$
$V_3 =$	$+1.41\,a$	$-2.28\,b$	$-0.244\,c$	$+4.14\,d$
	$+1.424\,a$	$-2.214\,b$	$-0.2368\,c$	$+3.987\,d$
	$+2.84\,a$	$-3.86\,b$	$-0.48\,c$	$+7.33\,d$
$M_3 =$	$-300\,a$	$+167\,b$	$-254\,c$	$-214\,d$
	$-315.8\,a$	$+172.4\,b$	$-242.3\,c$	$-244.9\,d$
	$-406\,a$	$+299\,b$	$-312\,c$	$-495\,d$

The standard formula, $d = \dfrac{PL^3}{3EI}$, where $E = 29{,}000$ kips per sq in., $I = 3{,}585$ in.^{4}, gives by substitution:

$$P = \frac{0.191 \times 3 \times 29{,}000 \times 3{,}585}{360^3} = 1.277 \text{ kips} \quad [2]$$

x_1, y, and z_1, multiplied by the constant P, thus give the reactions produced at the left base of the structure by a b movement of D_b in. Multiplying by the quotient, $q_b = \dfrac{P}{D_b} = \dfrac{1.277}{34.4} = 0.0371$, the horizontal, vertical, and rotational reactions due to a b movement of 1 in. are respectively:

$h_1 = x_1\,q_b = 48.2 \times 0.0371 = +1.79$ kips; $v_1 = y_1 q_b = -100 \times 0.0371 = 3.71k$; and $m_1 = z_1 q_b = +1{,}150 \times 0.0371 = +42.7$ in.-kips

The three values of r_b in Eq. 1 for the left base having been determined thus, the next step was to find the r_b values for the center base. Nailing the left column cross to the board in one of its deflected positions, the center column cross was released by pulling the nails, thereby causing it to deflect, the deflection being in the same direction as the b movement. Horizontal and vertical forces were then applied to the strips in the manner previously described, until the cross was brought back to its undeflected position with the strip holes directly over nail holes in the paper. The position of the eccentric force was then marked off as before, and the forces used were noted.

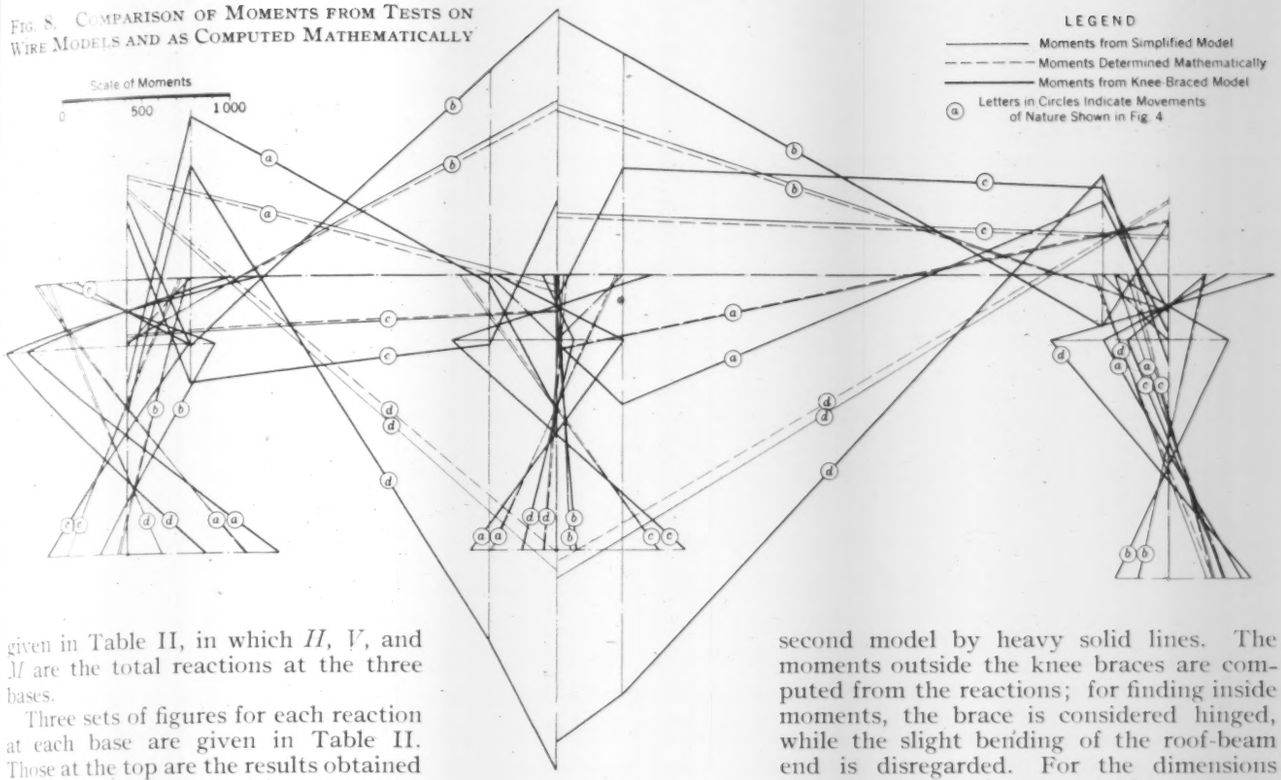
Taking, as before, the numerical averages of the values found for the two positions, the three reactions at the center base, x_2, y_2, and z_2 due to the displacement D_b, were obtained.

By the same method the effects of the displacement D_b upon the right base were determined, giving the reactions x_3, y_3, and z_3.

Multiplying again by the quotient q_b, the six remaining values of r_b in Eq. 1 were obtained.

The computations for the b movement are presented in Table I, while the final results for all four movements are

FIG. 8. COMPARISON OF MOMENTS FROM TESTS ON WIRE MODELS AND AS COMPUTED MATHEMATICALLY



given in Table II, in which H, V, and M are the total reactions at the three bases.

Three sets of figures for each reaction at each base are given in Table II. Those at the top are the results obtained from the model, Fig. 5 (*a*), while those in the center are values derived mathematically for the purpose of comparison. The agreement compares favorably with that obtainable with more refined equipment, and demonstrates the trustworthiness of wire models for analytical purposes.

TESTS ON MODEL WITH KNEE BRACES

The results will now be compared with those obtained by the use of a model conforming more closely to the structure. As stated, the latter is stiffened by knee braces, which were allowed for by considering the corners rigid. This, however, is only an expedient resorted to in order to avoid complications in the mathematical treatment, for whereas the problem, treated this way, is indeterminate to the sixth degree only, it would, if the braces were included as such, be indeterminate to at least the tenth degree. The work involved in solving four groups of 10 simultaneous equations may be profitably undertaken when dealing with structures of major importance, but is hardly warranted in a case of this type. When models are used, however, the way the problem is treated makes little difference in the amount of work.

A second model was accordingly made, as shown in Fig. 5(*b*). Its members were cut from the same wires as those in the first model, but knee braces were added. No lowering of the roof-beam wires was necessary in this case, the length of the column wires being maintained by extending the corner plates downward. The model was then subjected to the same series of operations as was the first one. A complete record of the measurements is shown in Fig. 7, the letters in circles indicating the movements, and the corresponding reactions are represented by the third set of figures in Table II.

For further comparison, the moments resulting from one inch of the respective movements have been shown graphically in Fig. 8. The moments obtained from the first model are shown by light solid lines, those derived mathematically by dashed lines, and those from the second model by heavy solid lines. The moments outside the knee braces are computed from the reactions; for finding inside moments, the brace is considered hinged, while the slight bending of the roof-beam end is disregarded. For the dimensions given in Fig. 4, the moment M_c at the intersection of beam and column center lines is then given by the relation: $M_c = -0.9\ M_k$, where M_k is the moment at the foot of the knee brace.

Comparing the results obtained from the two models, as presented in Fig. 8, we find them to be strikingly different. The moments from the second model appeared roughly about twice as large as those from the first, giving rise to high reactions at the knee-brace joints. These were, in fact, the points where weakness was first evidenced through shearing of rivets. Disregarding the knee braces involves errors of such magnitude as to make the outcome completely misleading, thus raising a point which is apt to be overlooked in treating problems of this type. Assumptions made in the interest of simplification which are safe when dealing with external loads are on the unsafe side when dealing with settlement, temperature, and yielding supports.

In conclusion, it may be said that models largely obviate the need for assumptions whose consequences may not be clearly realized. Moreover, they are easily made, and their operation, presenting step by step a clear picture of the effects produced, requires no expert theoretical knowledge. Results are obtained with a minimum of mental strain and in a comparatively short time.

As to their educational value, an investigation of even the simplest redundant structure, such as the continuous beam, requiring for a model only a piece of straight wire, will yield instructive results. Students desiring to acquire a clearer understanding of indeterminate problems will find model analysis a most helpful tool.

Information regarding the mechanical details of the wire models here described will be supplied to readers on request direct to Society Headquarters. Included are descriptions of the particular materials that have been found most useful in constructing such a model, as well as data on their availability and cost. Practical advice is also given as to the method to be followed in constructing the model and the tools needed for this purpose.

Future of Glass in the Building Field

Some Little-Known Facts About New Uses for an Ancient Product

By A. E. Marshall

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IF in future people who live in glass houses will refrain from throwing stones, as urged in the old proverb, then the stone-throwing era may soon be only a memory. At least, a 6-story office building now approaching completion has two of its exterior walls 80 per cent glass, with all interior partition walls and insulation entirely of glass. Even though this picture of all-glass houses may seem fantastic, hollow-glass construction blocks are available today for use in exterior and interior panels, fibrous glass for use as insulation, and transparent or opaque glass for segregating heat rays from light rays. These and many other interesting facts about the present and future of this material in building construction, together with data on the strength and conductivity of its various forms, are presented in the accompanying article, abstracted from Mr. Marshall's address before the Metropolitan Section of the Society on February 17, 1937.

THE ability to melt glass and form the molten mass into shapes has been traced back to such ancient times that we can properly refer to glass production as one of the earliest of the manufacturing arts. We tend to think of synthetic materials as manifestations of this present age of scientific research, but actually the ancient glass makers, who converted a dull gray mixture of alkali, lime, and sand into a durable ornamental material with a translucency surpassed only by natural mica, were practicing the art of synthesis. They were engaged in building up a new substance from its constituent elements.

The secrets of the processes of glass manufacture in past ages were closely guarded. This has been shown by chronological studies of specimens of antique glass and by the migrations of glass workers from retrogressing to advancing centers of civilization. The care with which the early glass workers handed down the secrets of their trade from one generation to the next accounts for the restricted use of this material, which until recent times was bound by the physical and chemical limitations of the traditional formulas. But within the last fifty years glass has exchanged its patriarchal garb for modern dress. Today we recognize that this age-old material has been endowed by research with new qualities.

The quality of transparency and the wide range of colors obtainable in both translucent and opaque types made glass a desirable construction material as far back as Roman times. In the House of the Faun at Pompeii small panes of cast glass set in bronze frames were used to admit light into the rooms, and amethyst and red glass tesserae were set in the pavements along with colored marble.

HOLLOW-GLASS CONSTRUCTION BLOCKS

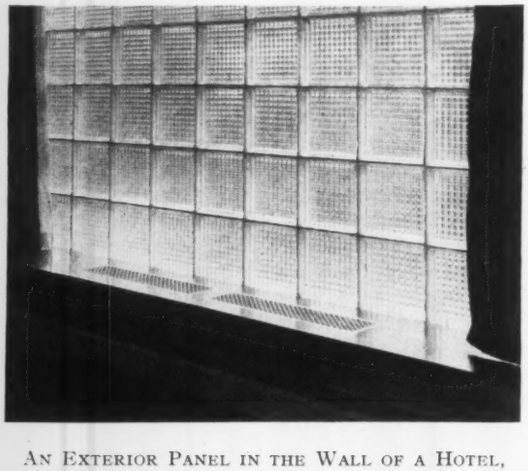
Recent growth of interest in maintaining controlled temperatures and humidities within buildings has resulted in a new consideration of construction elements. Limitations of windows, walls, and partitions as conductors of light, heat, and sound have become matters of considerable importance to the building industry. The need for an exterior wall material having a high degree of transparency in the visible part of the spectrum and useful thermal and sound insulating values has resulted in the development of hollow-glass construction blocks. These are smooth on their outer faces and scientifically patterned on their interior surfaces to give a wide angle of light distribution with an avoidance of glare. Not only does the hollow form provide effective thermal insulation, but appropriate spacing of the faces causes the resonance frequencies of the blocks to lie outside the range of usual noises so that considerable sound insulation is obtained.

The thermal effectiveness of these hollow construction blocks can be judged from their heat-transfer value of 0.5 Btu per sq ft per hr per deg F. An 8-in. brick wall will have a value of 0.6 Btu when measured under the same conditions. Sound-transmission experiments in the frequency range of 120 to 3,500 cycles per sec show a minimum loss of 24.6 decibels, a maximum loss of 42.9, and an average loss of 33.3. Test panels built of Corning Glass Works' heat-resistant glass construction blocks (cemented with a mortar containing 1 part cement, 1 part lime, and 3 parts sand) have successfully withstood the New York State standard fire test and have been approved by New York City for fireproof partitions and similar uses.

In compression tests these blocks show an average strength of 2,593 lb per sq in. for single units, and an average of 1,041 lb per sq in. for panels 4 blocks high by 3 blocks wide.

Thus research in the glass-plant laboratories has provided the construction industry with a new unit capable of many novel and interesting applications in industrial and residential structures. Future developments in the actual utilization of this product would seem to depend on the vision of the architect, the civil engineer, and the building contractor, and perhaps somewhat on trends in the art of building construction.

In addition to developing the hollow-construction block, the glass industry has made another interesting contribution in the field of building materials. Not content with the heroic feat of casting in one piece a telescope disk weighing some 20 tons, researchers have recently turned their attention to



An Exterior Panel in the Wall of a Hotel, Illustrating the Variety in Texture and Pattern of the Units

the infinitely small, and as a result we have glass fibers with filament diameters of 0.00015 to 0.0004 in.

DEVELOPMENT OF FIBROUS GLASS

Strictly speaking, fibrous glass is not a new material, since it has been made on a limited scale by more or less hand processes for many years. Although the fibrous glass of today and tomorrow must acknowledge its heritage of form from these hand methods, it is the child of research as regards both its composition and the mechanical methods of its production. The new glass filaments are produced on a quantity basis to close tolerances in diameters. In carded, slivered, and yarn form these inorganic commercial textiles differ appreciably from the "curiosity" textiles painstakingly fabricated from the filaments of the older processes. While the construction industry may have some interest in an inorganic textile for fireproof awnings, stage drapes, and even window curtains, it is to the many present and prospective uses of fibrous glass in buildings that attention will be directed here.

The glass construction block was developed to meet the need for comfortable working and pleasant living conditions, so it seems proper to first investigate the contribution fibrous glass is making in these same directions. Its use is of course limited to the opaque sections of wall and roof areas. Thermal insulation of walls and roofs has passed from the uncommon to the common stage, and many types of insulating materials, some organic and some inorganic, are now in use.

In the insulation type of fibrous glass, the individual fibers are surprisingly strong, the strength in pounds per square inch being equal to or greater than that of steel in fine-wire form. This high strength coupled with small diameter allows the fibers to bend without breaking and permits of uniform space dispersion at various degrees of compression. This last factor is important if a wide range of temperatures is to be considered, as it has been found that the density of the packing must be varied according to the temperature. Light packings are sufficient for ordinary temperatures, but much heavier ones are called for at high temperatures. Fibrous glass packings for the insulation of ordinary buildings against climatic changes are of the order of $1\frac{1}{2}$ lb per cu ft, whereas at 300 F the density should be doubled, and at 900 F, which is the upper limit of heat for the regular type of product, the desirable packing density is 6 lb per cu ft.

Solid glass is itself a fair insulator, having a value of the order of 4 Btu per sq ft per in. per deg F per hr. However fibrous glass, in the proper weight for buildings, has a conductivity of approximately one-fifteenth that for solid glass, or 0.28 Btu. At 300 F a packing of 3 lb per cu ft gives 0.42 Btu, while a 6-lb packing at 900 F gives a value of 0.6 Btu.

In the near future, building walls will be specifically designed to utilize insulation to the greatest advantage. Thus we can expect that the many present forms of fibrous glass insulation, such as bats, blankets, backed blankets, and nodulized material designed for blowing into the spaces between existing walls, will be replaced by one standard type having a maximum effectiveness and capable of easy application. The nature of this type will necessarily depend on the cooperation of glass technicians with those branches of the engineering profession concerned with structures.

Fibrous glass is receiving some experimental attention as a sound absorbent in the acoustical treatment of buildings. The British National Physical Laboratory recently carried out a series of sound absorption measurements in a reverberation chamber, using a 10-ft by 10-ft specimen. Their results indicate that glass "silk," as they describe the material, in 1- to 3-in. layers supported on 1- to 2-in. wood battens, has an average approximate sound absorption coefficient of 82 per cent over the range of 250 to 2,000 cycles per second. High-efficiency acoustic tiles, similarly supported on battens, were reported to average 70 per cent absorption in this same series of tests.

A GLASS BUILDING

Corning Glass Works, which is interested in the manufacture of hollow construction blocks and fibrous glass, decided in 1936 to combine its New York offices and the showrooms of Steuben glass in a building designed to demonstrate glass-block construction. This building, at 56th Street and Fifth Avenue, will be completed in September 1937. The showroom, with its mezzanine, is two stories high, while the office section extends four stories above the showroom. The exposed walls of the office section on Fifth Avenue and on 56th Street are approximately 80 per cent glass block, and the interior partition walls are glass blocks arranged in suitable panel sections. There are no windows in the office section, as the entire building is to be supplied with completely conditioned air. Dust and noise will both be eliminated, and changeable temperatures and humidities will be outside but not inside the building. Some of the offices will be acoustically treated with appropriate sound-absorbing glass products. The piping will be in ducts insulated with molded glass-fiber insulation, and even the sprinkler-head releases will be of glass.

Corning Glass Works, Corning, N.Y.

A STRIP OF FIBROUS GLASS BATTING. THIS FELTED, FLEXIBLE MATERIAL PROVIDES NON-INFLAMMABLE INSULATION

I have touched on only a few of the contributions which glass will make to the buildings of tomorrow. The list could be greatly extended. For example, researchers have done surprising things in developing glasses which effectively bar unwanted parts of the spectrum. Slightly greenish glasses are available which transmit 70 per cent of the visible rays and absorb 70 per cent of the infra red; and lighter colors, approximating plate glass in appearance, which transmit 80 per cent of the visible and absorb 50 per cent of the infra-red rays. It will be recalled that ordinary plate glass transmits 92 per cent of the visible rays and absorbs 16 per cent of the infra red.

Other glasses, when used with standard electric filament lamps, give a light which closely approximates north light in color, and still another type of glass is quite opaque to light but passes the infra-red heat rays freely. Perhaps this last type will find use in the home of the future for electric wall-panel heaters. But enough has been said to illustrate the statement that glass, although an age-old material, has recently been endowed with new qualities which fit it for a continuing place in this era of new requirements.

Technique of Soil Testing

As Applied by the U. S. Waterways Experiment Station to the Design of Levees and Earth Dams

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THE humblest of all the materials of construction—earth itself—has doubtless given the engineer more difficult problems to solve than timber, steel, and concrete together. Only in very recent years has it been possible to analyze these problems in the manner typical of current engineering practice, that is, on a basis of strength versus stress. Among the laboratories now engaged in the study of soil mechanics and its practical applications is the U. S. Waterways Experiment Station at Vicksburg, Miss. The present article describes the technique employed there in performing most of the more important routine tests, and gives examples of their use in the design of levees and earth dams. Mr. Buchanan's original illustrated talk, on which this paper is based, was presented before the Construction and Structural Divisions, on April 22, 1937, at the Spring Meeting of the Society in San Antonio, Tex.

INCREASING demands for the dependable control of floods have intensified the need for efficient and economical design of earth dams and levees. And such design has been made possible through application of the relatively new science of soil mechanics, which permits the problems of earth structures to be analyzed on a strength-versus-stress basis.

At the U. S. Waterways Experiment Station, Vicksburg, Miss., a special section has been devoted to the study of soil mechanics since 1931. The source of many of its problems has been, of course, the levee system of the lower Mississippi Valley—one of the greatest confining works created by man. At present, also, it is busy with studies for many projects involving the use of earth as an engineering material. The services of the Station are available to all offices of the Engineer Corps of the U. S. Army; consequently it may be called upon to study any type of problem involving the application of soil mechanics.

To illustrate the methods of determining the strength of soil, the steps followed in the solution of a levee problem will be taken up in order. These steps are: first, sampling; second, testing; and third, the application of these data in the solution of the problem.

Samples are of two types, general and undisturbed. They may be obtained from auger borings or from test pits, the former being the more economical of the two under normal conditions. The method of making the borings must be such that no disturbance of the material in place is caused by any driving action or jetting of the equipment in advance of the actual drilling. The advantage of the auger-type bit [Fig. 1(*a*)] is that it cuts into the material and brings the drillings to the surface for removal, inspection, and sampling. The general samples removed from the drill at frequent intervals are immediately placed in pint fruit jars, sealed air-tight, labeled, and shipped directly to the laboratory. Procurement of this type of sample at vertical intervals of approximately one foot makes it possible to verify, by laboratory tests, the field classification and field logs, and to trace the general condition of the strata.

Undisturbed samples are used for the detailed tests to determine the strength of the foundation material in place, and so must be handled with care. The device for obtaining them consists of a tube [Fig. 1 (*b*)] that fits snugly into the standard 6-in. pipe used to case the borings. It is about 2 ft long, and is fitted with a conical shaped top and a special cutting edge or shoe. The latter is arranged to make an opening into the soil slightly larger than the main barrel and to cut a sample slightly smaller in diameter than its interior; thus no skin friction is developed to distort the sample. Further, a wire snare is recessed in the shoe and operated by a cable from the surface to cut the bottom of the sample free when the tube is to be withdrawn. The samples, upon their removal from the tube at the surface, are promptly sealed air-tight with paraffin, and in the laboratory are placed in a humid storage room for safe-keeping.

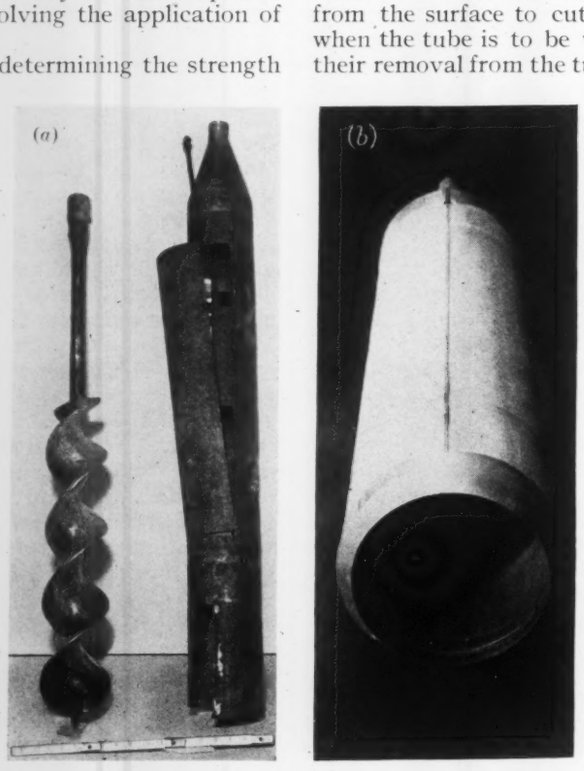


FIG. 1. SOIL-SAMPLING EQUIPMENT

(*a*) Auger-Type Drilling Bit; (*b*) Tube for Obtaining Undisturbed Samples (the Wire Snare Has Been Sprung)

It is all-important that the material in these samples remain unchanged. One of the most important factors is, of course, the moisture content; for if it varies, the changes produced by capillary action can completely alter the physical condition of the material.

Sites for levees cannot be chosen except within very restricted limits, and the materials used for their construction, because of economy, must be those nearest at hand. Hence, the first phase of the testing work is to ascertain what these materials are and their approximate condition. The general behavior of the three basic soils—sands, silts, and clays—is fairly well established by experience. Therefore, classification tests are first in order. From these data the correct logs of the borings are prepared, the gen-

eral arrangement of the strata established, and the probable weak spots located.

The general samples are first classified visually by an experienced operator thoroughly familiar with soils and with the essential features of the particular problem under investigation. The moisture contents of all the silt and clay samples are then determined. The operator removes a specimen (about one ounce) from the container, places it in a watchglass, clamped to be air-tight, weighs it to the nearest 0.001 gram, and then places it in an oven, thermostatically controlled to maintain a temperature of 105 C. After five hours the specimen is removed, placed in a dessicator, and allowed to cool to room temperature. The weighing is repeated and the moisture content computed (as a percentage of the solid, or dry weight). These results, plotted adjacent to the logs of the borings, give an excellent indication of the presence of excessively wet and weak strata in foundations or borrow pit areas.

METHODS OF MECHANICAL ANALYSIS

Mechanical analysis provides one of the most obvious means of classification. Yet, though it is of material assistance, the results should not be taken as a positive standard for comparison, for there are other properties which enter into a correct classification. The method used for mechanical analysis depends upon the material. For materials ranging from very fine sands to coarser materials, mechanically agitated, graded sieves are generally employed. The samples are thoroughly dried and separated by a sample splitter until a specimen of about 200 grams is obtained. This specimen is then weighed, placed in a family of sieves, the coarsest of which will pass the largest grains, and shaken in a mechanical agitator for 20 minutes. It may be noted that these sieves are of the half-height caliber; thus the specimen can be separated into a greater number of increments than when the standard, full-height size is used. The contents of each sieve are removed and weighed at the proper time. These data, coupled with the sizes of the sieve openings, are used to compute the various percentages.

The finer grained materials, which are too small to be separated by sieves, require separation by the hydrometer method. A specimen of about 50 grams is dispersed in distilled water with a small amount of deflocculating agent added (15 drops of sodium silicate), transferred to a liter graduate, and again thoroughly dispersed for one minute. The time of the test is taken from the instant this second dispersing is stopped. A density hydrometer (range 0.995 to 1.030) is inserted, and the decrease in density of the suspension is observed with respect to time. These observations are continued on a definite schedule until grains of 0.2 micron in size have settled past the center of flotation of the hydrometer, or for approximately 96 hours. The suspension is then transferred to a dish, evaporated, and weighed. From these data the size and percentages of the various grains can be computed.

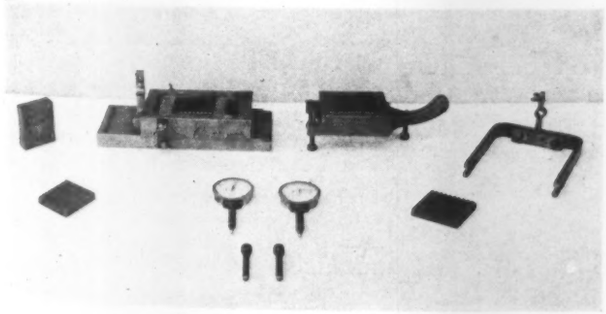


FIG. 2. PARTS OF SHEAR BOX USED FOR DELAYED SHEAR TEST

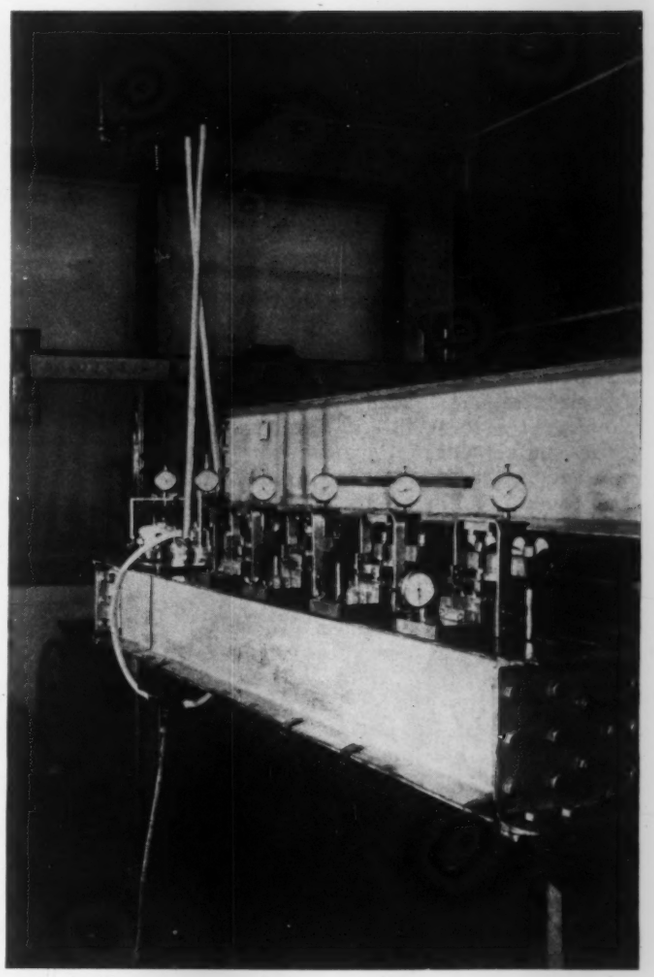


FIG. 3. LOADING MACHINE WITH CONSOLIDOMETERS AND SHEAR BOXES

One Consolidometer Is Fitted with Vertical Standpipe for Permeability Test

Other tests, such as the Atterberg limits and absolute specific gravity, are used in conjunction with those just described for differentiating between materials that appear quite similar but whose general behavior is known to be different.

TWO TESTS FOR SHEARING STRENGTH OF SOILS

One of the all-important factors in the design of side slopes for an earth structure and for ascertaining the stability of a foundation formed of cohesive silts or clays, is the shearing strength of the soil involved. This strength may be determined by either the delayed shear test or the quick shear test. The former is used to determine the angle of internal friction of borrow-pit material for use in the design of side slopes and, by using undisturbed samples of a foundation material, for ascertaining the ultimate strength that it will develop through consolidation. The quick shear test, using undisturbed samples, indicates the strength of a foundation material as it exists at the time of sampling.

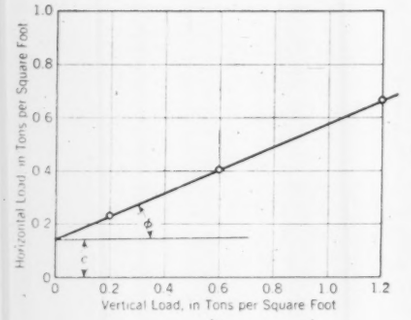
The equipment for delayed shear tests consists of a shear box (Fig. 2), made in two parts, the upper one movable and the lower one fixed, and a machine for applying vertical and horizontal loads to the specimen contained in it. An opening 2.362 in. square extends

through the upper part of the shear box and into the lower part, to contain the specimen and accessories. To aid consolidation, grooved porous stones are placed above and below the sample to allow free drainage of the void-contained water. Brass plates of the same shape may be substituted when no consolidation of the specimen is desired. Saw-toothed grooves are formed in the plates to distribute the shearing stress uniformly over the specimen. The displacement of the top part of the specimen during the application of horizontal load is measured by an extensometer to 0.0001 in., and the vertical movement of the piston during the consolidation of the specimen is observed in a like manner.

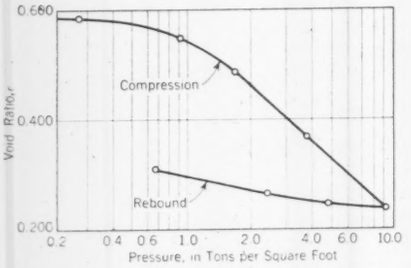
A specimen from an undisturbed sample is cut with a special device so that it will be of exactly the same dimensions as the opening in the shear box, and about one inch thick. When its top surface has been grooved to fit the porous stone or brass plate, it is inserted into the top part of the shear box; then the bottom surface is prepared in like manner and the parts of the shear box are joined together. Three or four specimens from each sample are prepared in this way. The boxes are arranged on the loading machine (Fig. 3), where vertical loads ranging from about 0.1 to 1.0 tons per sq ft can be applied. Sufficient time is allowed for each specimen to consolidate fully under its applied vertical load. Then, by means of a system of levers, a horizontal load is applied in increments on a definite time schedule, and the corresponding displacement is observed. A stress-strain curve is plotted for each specimen, from which the stress that produces failure is readily detected.

The strengths of the several specimens are plotted against their corresponding vertical loads to obtain the familiar shear diagram of Fig. 4(*a*). When plotted to an arithmetic scale, this curve is a straight line whose slope is taken as the angle of internal friction, ϕ. The ordinate-intercept, c, is the shearing strength due to cohesion. The ultimate strength in shear then, under any normal pressure P, is $P \tan \phi + c$. For sands, c is of course zero, while for fine-grained clays in a well consolidated state, it may amount to 0.3 or 0.4 ton per sq ft.

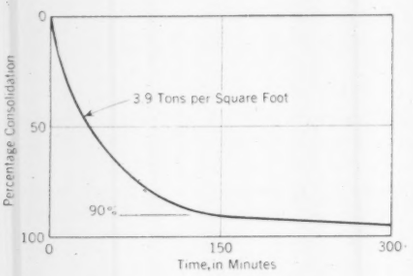
The strength of borrow-pit material to be used in an earth structure may be determined by the use of a general sample whose condition—that is, void-ratio, water content, and so forth—is made to duplicate its essential condition in the structure. The test is performed in the manner just described, using the remoulded specimens that have been fully consolidated under various vertical pressures.



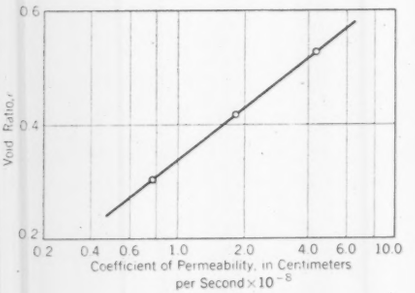
(*a*) Shear Diagram



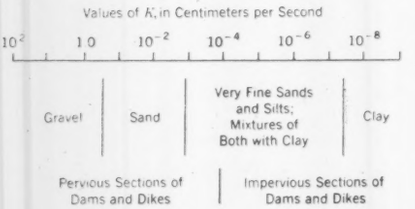
(*b*) Consolidation Diagram



(*c*) Time-Consolidation Diagram



(*d*) Permeability Diagram


Values of K, in Centimeters per Second
Gravel
Sand
Very Fine Sands and Silts; Mixtures of Both with Clay
Clay
Pervious Sections of Dams and Dikes
Impervious Sections of Dams and Dikes

(*e*) Range of Permeability and Approximate Limits of Usefulness for Various Soils

FIG. 4. TYPICAL DATA CURVES FROM LABORATORY TESTS OF SOILS

The quick shear test is made to ascertain the strength in situ of plastic foundation materials, and hence their relative stability against lateral displacement. The shear box used in this case (Fig. 5) has a rigid bottom and sides, but the ends are open. A test specimen, 0.7 in. thick, is cut from an undisturbed sample to fit the horizontal cross-section of the box. It is confined between two rigid pistons, contact with which is assured by spring-bronze teeth projecting into the specimen. The apparatus is so arranged that the strain produced by the stress applied with the scale loading device may be observed continuously. The test is completed in about four minutes, so that no consolidation will occur. In failing, the specimen is displaced in a manner that closely simulates the actual failure of the foundation in the prototype. The strength of the material, S_q, may be computed by the basic equation developed by Dr. Leo Jurgenson:

$$S_q = \frac{Pa}{BL^2\left(1 + \frac{\pi a}{l}\right)}$$

in which P represents the load producing failure; a, one-half the thickness of the test specimen; B, its width; and L, one-half its length.

DETERMINING THE AMOUNT AND RATE OF SETTLEMENT

When the design of a levee section has been adjusted to meet the requirements for stability, both as regards side slope and foundation, the next step is to determine the settlement to be expected and the rate of its development. A knowledge of these factors permits adjustment of the gross section to allow for the estimated settlement, and thus eliminates the necessity of later additions. The data required are obtained from tests of the cohesive foundation materials only, for the cohesionless gravels, sands, and coarse silts consolidate so rapidly that any settlement in nature due to their readjustment will occur during construction.

The test equipment includes a consolidation device and a machine for applying vertical loads. It is arranged so that an undisturbed specimen may be isolated in an accurately machined cylinder, loads applied in any desired increments, and the physical action occurring in nature reproduced Escape of the water during

consolidation is facilitated by porous filter stones immediately above and beneath the specimen.

A specimen of an undisturbed sample is cut to the exact diameter of the cylinder (4.250 in.), and pushed directly into it from the cutting device. The protruding ends are then struck off to form plane surfaces, and the equipment is assembled, placed on the loading machine (Fig. 3), and the first load applied.

The actual consolidation under load is measured to 0.0001 in. Readings of the extensometers are taken according to a prearranged schedule until the specimen is fully consolidated, as indicated by the cessation of vertical movement. This operation is repeated, using successively greater loads, until the total pressure materially exceeds that which may be expected to occur in nature. The specimen is then removed, weighed, dried, and weighed again. As both the water and the soil are relatively incompressible, any reduction in the total volume must be due to the expulsion of excess water during the rearrangement of the grain structure. The ratio of the volume of the water-filled voids to the absolute volume of the soil portion is defined as the void-ratio, e.

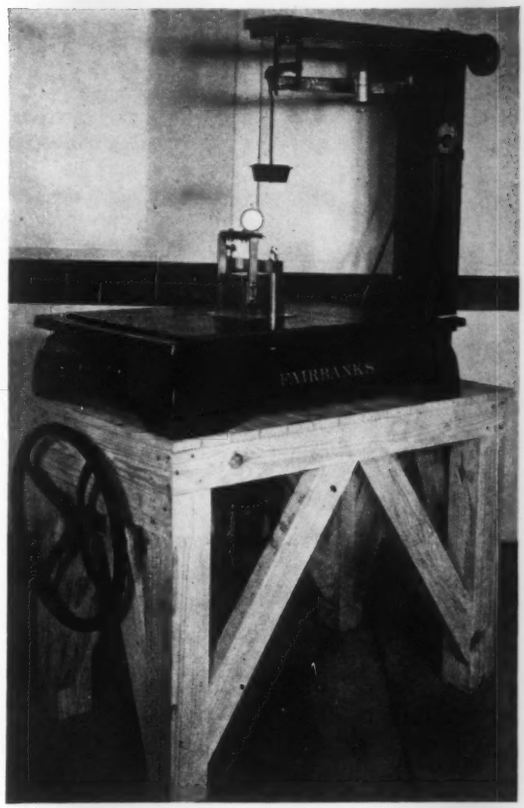


FIG. 5. SET-UP FOR QUICK SHEAR TEST

The results of this test are shown graphically in Fig. 4(*b*). Each point indicates the void-ratio after full consolidation has occurred under one increment of load. The rate at which the specimen consolidates under a given increment of load is indicated in Fig. 4(*c*).

The use of these data to estimate the rate at which a structure will settle as a result of consolidation in one stratum, can be illustrated by a simple problem. Assume the structure will exert an increased pressure of 3.9 tons per sq ft over that already on a stratum of clay 10 ft thick, whose initial void-ratio, e_i, was 0.50. By Fig. 4(*b*), this initial void-ratio would be reduced to a final void-ratio, e_f, of 0.38. The total settlement to be expected is then $\frac{(e_i - e_f)h}{1 + e_i}$, or 0.8 ft. The rate of settlement may be ascertained from Fig. 4(*c*). It has been found by experience that full, or 100 per cent theoretical, consolidation it equivalent to about 90 per cens of that observed in the test; and in the figure, 90 per cent consolidation is indicated as developing in 150 minutes. The time scale is the ratio of the squares of the thicknesses of model and prototype. Thus, if the specimen is 1.25 in. thick, the time required for full consolidation of the prototype stratum is

$$\frac{(10 \times 12)^2}{(1.25)^2} \times \frac{150}{24 \times 60} =$$

960 days.

MEASURING PERMEABILITY

Permeability tests are performed to determine the coefficient to be used in applying Darcy's law to the flow of seepage through a levee or earth dam or its foundation. To estimate the flow of water through an existing structure and its foundation, or through the foundation of a proposed structure, the test sample should be undisturbed, or as nearly so as possible. For proposed structures, of course, general samples must be used; however, they are remoulded and their condition is made to simulate that which will ultimately exist in the structure.

The consolidation-test apparatus is used for permeability tests of silt and clay materials. A calibrated vertical standpipe of small bore (about 5 mm) is attached to the connection in the base of the apparatus, and filled with water. The hydrostatic pressure causes flow upward through the specimen and escape at its upper face. The factors involved, all of which can be readily measured, are a, area of standpipe; L, length of specimen; A, area of specimen; and t, the time required for H_1, the initial head, to decrease to H_2. The coefficient of permeability is then $K = \frac{aL}{At} \log_e \frac{H_1}{H_2}$. It is determined for each material at several void-ratios, and a curve is plotted [Fig. 4(*d*)] to establish the relation between the two. Generally K is expressed in centimeters per second. The variation to be expected from the various materials

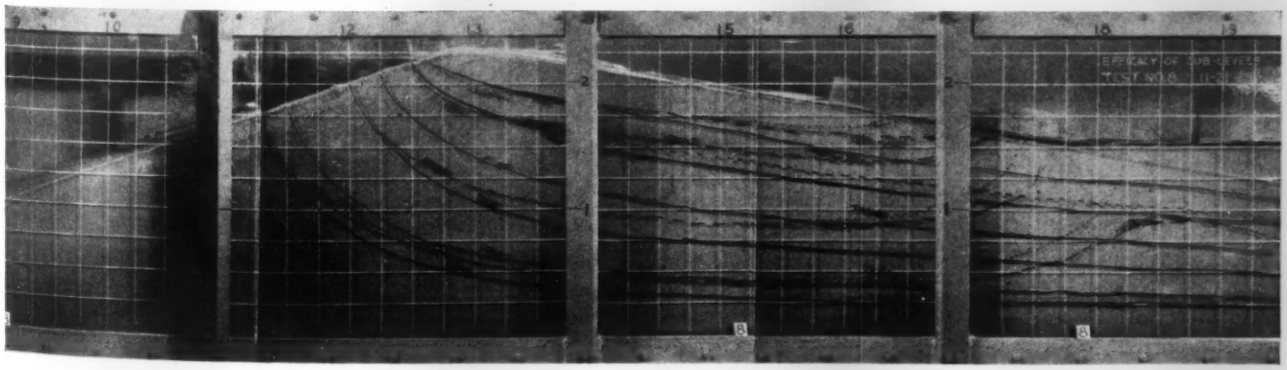


FIG. 6. THE SEEPAGE FLUME, WITH A LEVEE MODEL UNDER TEST. DYE WAS USED TO TRACE THE FLOW THROUGH THE SECTION

encountered in general construction is as shown in Fig. 4(*e*).

The *K*-determination may be made simultaneously with the consolidation test, during the interval between the complete consolidation under one increment of load and the application of the next increment. The permeability of sand and coarser materials is determined in the same general manner, but with equipment that permits greater rates of flow.

TROUBLE THAT COULD HAVE BEEN AVOIDED BY LABORATORY STUDY
Typical Failure in an Earth Dam, Caused by Excessive Slopes and Inadequate Control of Water Content

Seepage through earth embankments and their foundations presents two problems—first, the quantity of water that must be disposed of, and second, the tendency of this flow to decrease the stability of the side slopes. The first of these problems is usually of little importance, since the normal drainage system of the area adjacent to a levee is more than adequate for the disposal of seepage. The second problem, however, demands consideration, for the basic requirement of any structure is that it must be stable.

The solution of both these problems may be accomplished by observing scale models constructed in a glass-sided flume (Fig. 6). Materials for constructing a model are selected so that the permeability coefficients for the foundations and the structure itself are in the same ratio as in the prototype. Flow distortion due to capillary action is minimized by using relatively coarse materials for the models. Water is impounded above and below the model as desired, and the path of the seeping water is traced by the introduction of small streams of dye at critical points. From these data a flow net and equipotential lines are developed for estimating both the quantity of seepage and the hydrodynamic effect of this flow on the stability of the side slope.

The application of the data supplied by some of these tests may well be illustrated by explaining part of the general design of a levee. The design of the side slope, based entirely on the strength of the material to be used, may be accomplished to give any factor of safety desired. If sand, a cohesionless material, is to be used, the slope must not exceed the angle of internal friction; in fact, it should be approximately 10 per cent less. The situation is entirely different when silts or clays are to be used. The failure of a slope formed of these soils is not by sloughing along the surface, as is the case with sands, but along a deep-seated cylindrical surface that generally extends from a point just back of the crown of the slope to a point near its toe. When failure takes place, the segment of the slope lying above this arc appears to slide downward with a rotary motion. The approximate position of the center of this rotation can be determined. This type of failure is due to overstressing of the material in shear.

The steps taken in the design of a slope are as follows (Fig. 7): First, the approximate center of rotation and arc of failure (*BCD*) are determined; second, the segment of the slope lying above this surface is subdivided into vertical strips of unit thickness; and third, the forces, ΔW, created by each strip are determined and resolved into their tangential and normal components, ΔT and ΔN, at the intersection of the line of action of ΔW with the arc. The total force tending to produce failure is the summation of the ΔT's. This force is resisted by the shearing strength of the soil, along the arc, due both to the friction developed and to the cohesion of the material. The friction is the summation of the ΔN's multiplied by the tangent of the angle of internal friction. The cohesive strength, c, is independent of the pressure at any point on the arc of failure, and is measured directly in the shear test. The total cohesive resistance is the product of c and the length of the arc.

The factor of safety of the slope is the ratio of the computed strength to the computed stress—that is, $[cBD + (\Sigma \Delta N) \tan \phi] / \Sigma \Delta T$. The usual practice is to design with an initial factor of safety of 1.50; as the structure ages, the cohesive strength of the material increases, resulting in a corresponding increase in the margin of safety.

The soils laboratory at the U. S. Waterways Experiment Station has completed a good many investigations of the type outlined here. Some of the more recent include the design of a levee unit across an extensive swamp in Illinois, which required checking and preventing lateral displacement of a highly plastic clay foundation material; the redesign of an earth dam 150 ft high in Oklahoma; an investigation of the stability of the fill being placed to provide a site for the Golden Gate Fair in San Francisco Bay; and a study of the lateral pressures exerted against dams or retaining walls by fresh sedimentary deposits.

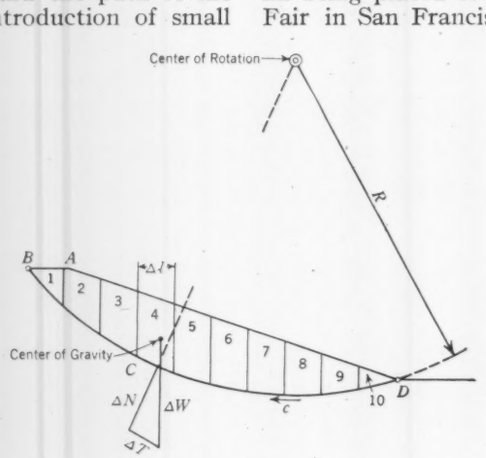


FIG. 7. ANALYZING A SLOPE FOR STABILITY

The former director of the Station, Francis H. Falkner, Jun. Am. Soc. C.E., First Lieutenant, Corps of Engineers, has done much to foster the development of the laboratory. I wish to thank him for his cooperation in making this paper possible. I wish also to acknowledge the assistance, in preparing the paper, of members of my laboratory staff, in particular Robert M. German, junior engineer; William J. Rowland, chief technician; and Francis B. Gauthier, photographer.

Colorado River Water for California

Initial Aqueduct Development Now Two-Thirds Complete

By JULIAN HINDS

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WITHIN less than three years, the Colorado River aqueduct will be carrying water across 300 miles of mountain and desert to the cities of southern California. Only about one-third of the minimum ultimate need for water there can be supplied by local sources. Including the Owens River aqueduct supply, only half this need can be met. Hence the remaining half is being provided by the Colorado River aqueduct, utilizing the flood flows of the Colorado River, trapped in Lake Mead behind Boulder Dam. Many details of this outstanding work, designed for an average delivery of 1,500 cu ft per sec, are given in this abstract of the paper presented by Mr. Hinds before the Construction and Structural Divisions in joint session on April 22, 1937, at the Society's Spring Meeting in San Antonio.

IT IS sometimes difficult to explain southern California's water problems to people in other areas—even the people of other arid western states. Diligence in the conservation of water and care in its use are in California carried to an extreme which irrigators and water consumers elsewhere find it hard to comprehend.

This condition is brought about by two factors, the extreme scarcity of water and its unusually high value for agricultural, industrial, and other uses. Los Angeles is surrounded by a fertile basin having a habitable area of about 1,400,000 acres, about 1.4 per cent of the gross area of the state. Within this basin are to be found nearly half the wealth and population of the state—and about 1 per cent of its water resources. Thus it is easy to see why water is at a premium. Except at times of extreme flood, every drop is saved for use.

In most parts of the country, the large floods which occur at intervals of 15, 10, or even 5 years must be permitted to run to waste, because the cost of the average yield resulting from their control is prohibitive. But in southern California, a farmer with nearly enough water to mature a citrus crop at a normal or reasonable cost, can pay dearly for the small additional amount required to insure success. This condition encourages the most complete conservation and diligent elimination of all waste.

Conservation is accomplished largely by underground storage in the vast debris basins which underlie the area. The natural absorption is materially aided by artificial spreading works, and the stored water is recovered by pumping from wells. Waste is eliminated by the use of closed-conduit systems for irrigation, which approximate the systems used for domestic supply.

In spite of the utmost care, the water naturally available to southern California is wholly inadequate for the full development of the region. When completely developed, local sources are expected to yield somewhere around 1,000 to 1,200 cu ft per sec. The minimum ultimate need is not less than three times this amount.

The nearest important water source lies 200 to 300 miles to the north, in the snow-capped high Sierras. These sources drain largely to the west, into the San Joaquin Valley, where they have long been over-appropriated. The eastern slopes of these mountains are steep and narrow, and drier than the western slopes, yielding a much smaller water crop. During the last 30 years, the City of Los Angeles has acquired and developed a right to about 450 cu ft per sec of water from this area. For this purpose, the Owens River aqueduct was constructed, from 1907 to 1913—a 250-mile line of canals, conduits, pipe lines, and tunnels, costing $23,000,000 for original construction, plus more millions for water rights, improvements, and extensions. This aqueduct serves Los Angeles alone, but by releasing waters that might otherwise have been conscripted for city use, has immeasurably benefited the entire area. At present the system is being extended further north to increase the dependability of its supply. Combined with local waters, it brings the available water supply up to about half the minimum ultimate need for the region.

THREE HUNDRED MILES TO THE NEXT WATER HOLE

A full measure of prosperity cannot, of course, be maintained on half enough water. A careful survey of all possible outside sources reveals that there is only one additional source to which to turn—the Colorado River. This stream taps the snow banks of Colorado, Wyoming, and Utah, bringing down vast flows of water heretofore put to no useful purpose. The unused part of this flow

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COMPLETED SECTIONS OF OPEN-LINED CANAL AND BOX SIPHONS
Looking West from Over Contractor's Camp

PAVER FOR PLACING RELATIVELY DRY CONCRETE LINING MONOLITHICALLY
As Much as 944 Ft of Canal Lining Has Been Placed and Finished by One Machine in a Two-Shift Day

has always come down in floods of short duration, impracticable of direct diversion. But now these floods are to be smoothed out in Lake Mead (the reservoir formed by Boulder Dam) and put to work.

This stream was early recognized as the last water hole for southern California. It lay 300 miles away, across an inhospitable area of mountains and desert. But the need was great. The barriers are being broken down, and thus there is emerging a far-flung line of waterways, known as the Colorado River aqueduct, which promises to southern California the remaining half of its minimum water need.

Water for this system is to be released from Lake Mead into the river channel, and rediverted at Parker Dam, 155 miles downstream. The main Colorado River aqueduct consists of a series of concrete-lined tunnels, concrete pipe lines, buried concrete flow-line conduits, and concrete-lined canals, with a total length of 242 miles. The tunnels total 92 miles in length and are of horseshoe section, 16 ft in diameter. The other parts of the line are of comparable size. The line is designed for a peak discharge of 1,605 cu ft per sec, with an average of 1,500 cu ft per sec.

The water level above Parker Dam is to be 450 ft above sea level. Parts of the area to be served lie at 1,000 ft or more above sea level. Also, fall must be provided to maintain flow in the conduits, and mountains must be crossed; hence the water must be pumped. A total lift of 1,617 ft is required. This is to be provided by a series of five pumping plants, distributed along the line as topography requires. The individual lifts vary from 144 to 441 ft. Each plant will ultimately contain 9 single-suction, single-stage, vertical pumping units, with a capacity of 200 cu ft per sec each. The ultimate power consumption will be 344,000 hp. As far as available, this energy is to come from the government plant at Boulder Dam; 36 per cent of the firm output of the Boulder power plant has been allocated to this use, and also first call on all secondary power. Some supplemental power source may ultimately be needed.

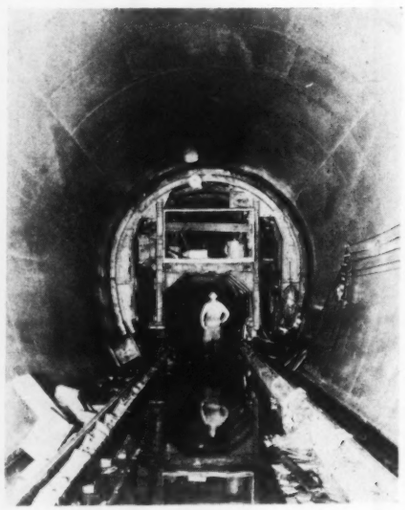
The main aqueduct is now well along toward completion. All the siphons and lined canals are finished. About 10 miles of covered conduit remains to be built. All but one of the 29 main-aqueduct tunnels have been excavated, and the concrete lining is practically finished. The one exception is the 13-mile San Jacinto Tunnel, which pierces an arm of snow-capped Mt. San Jacinto. Because of the great depth of cover, access to this tunnel at interior points is difficult and it must be constructed from a limited number of faces. Although it was started first, to compensate for this, many difficulties have been encountered, and its construction has fallen somewhat behind schedule. The ground has been fractured, and large, sustained flows of water under high pressure have been encountered.

Up to July 1, 1937, a total of 8.8 miles of tunnel had been excavated at San Jacinto, leaving 4.2 miles yet to be done. In an attempt to restore the original schedule, a new entrance is being constructed near the middle of this reach. This entrance, known as the Lawrence adit, is a little over a mile long, and is excavated on a 25 per cent slope. As a further aid to early completion, small pioneer bores are being built parallel to and in advance of the main headings. They are about 10 ft by 10 ft in cross-section, and can be carried through the heavy sections much more safely and quickly than the full-size bore. They permit exploration and drainage of faulted, water-bearing seams, and have many auxiliary uses as well. Should the need arise, they can even be used for the transportation of a reduced aqueduct flow, pending the completion of the main bore.

NEW CONSTRUCTION METHODS DEVELOPED

The work on the aqueduct has resulted in many improvements in construction equipment and procedure. Particularly notable are the machines developed for trimming banks and for placing concrete lining on the open canal. They are speedy, economical, almost wholly automatic in operation, and yield an excellent finished product. Similar machines and special forms and placing equipment have expedited work on the buried conduits.

In the tunnels, the old heading-and-bench procedure has been almost entirely eliminated. Drilling is done with automatic feed drills mounted on jumbos, which so greatly facilitate full-face drilling as to render heading drilling during the mucking operation unnecessary. Small shovels were used successfully for mucking in a few tunnels, but an 18-ft excavated diameter was a little tight for them. Most of the material has been loaded with Conway muckers. An especially interesting adaptation of the Conway mucker is in use at the Lawrence adit. This machine is counterweighted so that it can move up and down the 25 per cent slope under its normal power, and the dipper has been redesigned to lift the material to a greater height, thus permitting the conveyor belt to run approximately parallel to the track. The belt slope of the standard machine, added to the slope of the track, was



SECTION OF FRESHLY STRIPPED CONCRETE ARCH IN VALVERDE TUNNEL, WITH FORMS IN BACKGROUND

too steep for successful operation. Without this machine, not more than 5 or 6 ft of adit could be excavated per day; with it, progress is about that per shift, with a maximum of 27 ft in a three-shift day.

Both trolley and battery locomotives, and standard dump cars, were used for hauling. Much ingenuity went into the construction of car-shifting devices, designed to minimize the idle time of the mucker. A welded portable switch, which could be pulled along the top of the standard track and thus kept close to the working face, was a favorite. There were numerous types of "cherry pickers," or hoists, for lifting an empty car clear of the track, to one side or above the train. An interesting device, called a "grasshopper," permitted a whole train of empties to be stored on the upper deck of a steel trusswork, to be fed off a movable ramp in front, as required.

Tunnel lining was all placed mechanically. Standard pneumatic equipment was used with success, and a new device was developed, consisting of a plunger pump with

PLACING SECTIONS OF PRE-CAST CONCRETE PIPE
For Scale, Note Men to Right of Suspended Section

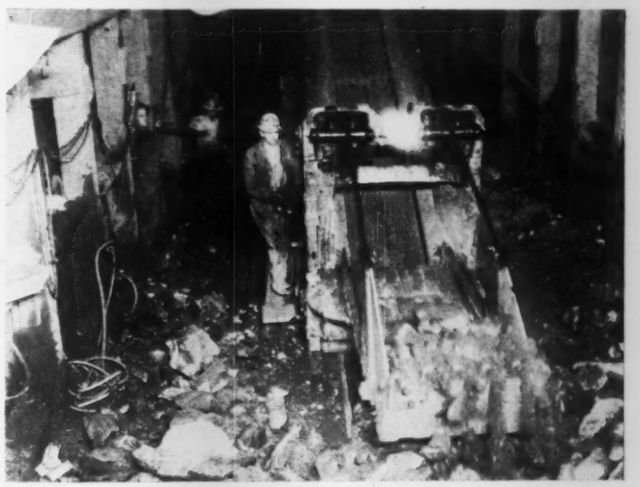
mechanically actuated valves. This pump handles concrete of superior consistency and is claimed to be particularly efficient for filling roof cavities.

The main aqueduct terminates near Riverside, some 75 miles from Los Angeles, where it discharges into the Cajalco Reservoir. This basin, now under construction, will have an initial capacity of 100,000 acre-ft and may be enlarged to more than double that capacity. It is formed by an earth dam 194 ft high and 2,600 ft long, and a dike 90 ft high and 7,600 ft long.

The water will be withdrawn from Cajalco by tunnel, and conveyed to points of use by a system of feeder pipe lines. The first unit of this system, known as the main upper feeder, has a total length of 62.5 miles, of which 10.2 miles is high-head steel pipe; 16.2 is pressure tunnel; and the remainder is pre-cast concrete pipe. Diameters range from 12 ft 8 in. to 9 ft 8 in.

The pre-cast pipe installation is especially noteworthy, involving larger pre-cast pressure pipes than have been previously attempted. For a length of 9.6 miles, this pipe has a diameter of 12 ft 8 in. It is cast in 12-ft lengths, in rather elaborately equipped yards at convenient locations along the line. The sections, weighing up to 42 tons each, are transported to the trench on specially built pneumatic-tired trailers, and are placed by travelers or cranes designed for this service. The manufacture and placement of this pipe have gone forward with notable success and speed.

Approximately half of the tunnel work on the main aqueduct is being done by force account; nearly all the remaining work has been or will be let by contract. All features, except the San Jacinto Tunnel, are being completed on schedule, and below or very close to the estimated cost. Many records have been established: 55 ft



TUNNEL MUCKING MACHINE OF CONWAY CONVEYOR-LOADER TYPE

of 16-ft diameter rock tunnel was excavated in a single day; on another day 93 ft of 10-ft tunnel was constructed in alluvium; and 944 ft of 8-in. lining was laid in one of the many canals in a two-shift day.

PRESENT STATUS OF THE PROJECT

Except for siphons and pumping units, the main aqueduct is being constructed to its full ultimate capacity of 1,605 cu ft per sec. Three out of the ultimate nine 200-cu ft per sec pumps are to be installed in each pumping plant, but provision is being made for the quick addition of two more units when needed. When the demand exceeds 800 cu ft per sec, it will be necessary to provide additional delivery lines at the pumping plants, and to duplicate the longer main-aqueduct siphons, which are double-barreled, one barrel being omitted at this time. The initial distributing system will handle about half the ultimate flow. Additional lines will be built as needed.

It is estimated that the initial development will cost $220,000,000, and will be completed in 1939. It is now about two-thirds complete. Funds for construction are derived from the sale of bonds, all sales to date having been made to the Reconstruction Finance Corporation, except for a $1,500,000 sale to PWA for a part of the construction of Parker Dam. The project was conceived in the optimistic years of 1928 and 1929, and was in no sense a make-work venture. However, financing was not completed until near the end of 1932, and actual construction was started about the beginning of 1933, in the depth of the depression. Although not so planned, the project has been of inestimable benefit not only to southern California, but also to the purveyors of materials and equipment throughout the nation.

The controlling agency is the Metropolitan Water District of Southern California, which is composed of 13 cities in Los Angeles and Orange counties, with a combined population of 1,850,000. The District is governed by a board of directors, of which W. P. Whitsett is chairman. F. E. Weymouth, M. Am. Soc. C.E., is general manager and chief engineer.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Discharge of Needle Valves and Sluiceways at Madden Dam

By P. S. O'SHAUGHNESSY

JUNIOR ENGINEER, THE PANAMA CANAL, BALBOA HEIGHTS, CANAL ZONE

Detailed operating tests of large regulating works are relatively rare; hence this report on the methods and results of testing the outlet structures at Madden Dam should be of especial value. A paper describing tests of spillway discharge at the same dam was published in the May 1937 issue of "Proceedings."

THE regulatory works at Madden Dam include two outlet pipes equipped with needle valves, and six rectangular sluiceways controlled by gates. Tests have been made to determine the actual head-discharge relationship for both of these appurtenances.

NEEDLE-VALVE TESTS

Figure 1, a longitudinal section of the needle-valve installation, shows the general arrangement of the testing apparatus. To measure the discharge, two streamlined supports, one horizontal and the other vertical, were installed in the pipe at *A*. On these supports 13 piezometer nozzles were arranged in three concentric circles. An individual tube led from each nozzle to a manifold on the gage-board (Fig. 2), and the latter in turn was connected to one leg of a mercury differential manometer. From the other leg of the manometer a tube led to a piezometer ring that circled the outlet pipe 4 in. upstream from *A*. With these connections readings could be taken on each pitot tube separately or on any desired combination of tubes. After converting the manometer readings to velocities, and constructing the velocity-area curves, the discharge was determined by means of a planimeter.

During the tests the reservoir level ranged between El. 140 and El. 235, corresponding to heads of from 26.5 to 121.5 ft. At each of ten heads in this range the valve was tested at 0.2, 0.4, 0.6, 0.8, and full valve opening. It might be well to point out that "opening" does not mean percentage opening of the nozzle, but horizontal travel of the needle itself. Thus since the total travel of the needle is 36 in., 0.2 opening signifies that the needle is 7.2 in. from its closed position.

The pitot tubes were read both individually and collectively. A comparison of the two methods shows that the mean velocities from the collective readings are 101.56 per cent of the velocities obtained from the individual readings, the variation ranging from 103.22 to 100.30 per cent. The substitution of collective readings for individual readings would produce an average error of 1.5 per cent.

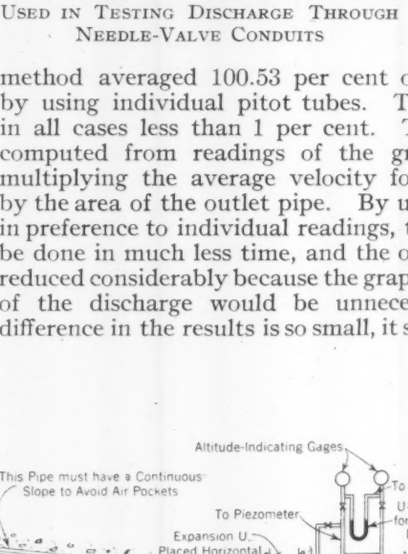


FIG. 2. GAGE AND MANOMETER BOARD USED IN TESTING DISCHARGE THROUGH NEEDLE-VALVE CONDUITS

A similar comparison between the "group" method (collective reading of four tubes equidistant from the center of the pipe) and the individual readings shows even closer agreement. The discharges obtained by the group method averaged 100.53 per cent of the values found by using individual pitot tubes. The discrepancy was in all cases less than 1 per cent. The discharges were computed from readings of the groups of tubes by multiplying the average velocity for the three groups by the area of the outlet pipe. By using group readings in preference to individual readings, the field work could be done in much less time, and the office work would be reduced considerably because the graphical determination of the discharge would be unnecessary. Since the difference in the results is so small, it seems that the group

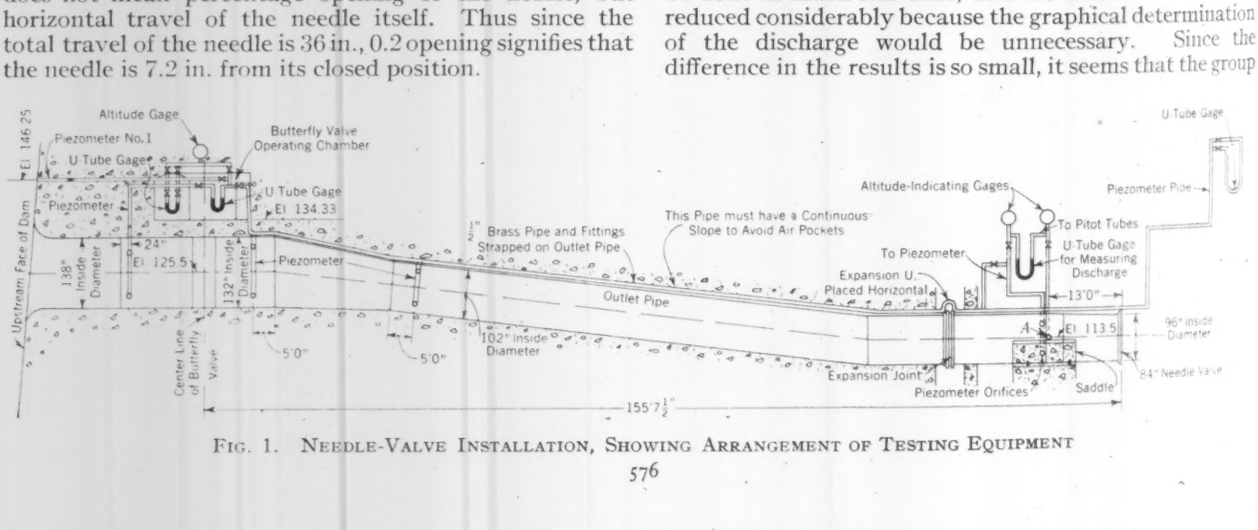


FIG. 1. NEEDLE-VALVE INSTALLATION, SHOWING ARRANGEMENT OF TESTING EQUIPMENT

method may be used to advantage, especially under conditions where economy and rapidity are the main factors.

By means of the other testing equipment shown in Fig. 1, the entrance loss was found to be less than 1 per cent of the total head throughout the range of elevations tested. It may be expressed as $0.113V^2/2g$, in which

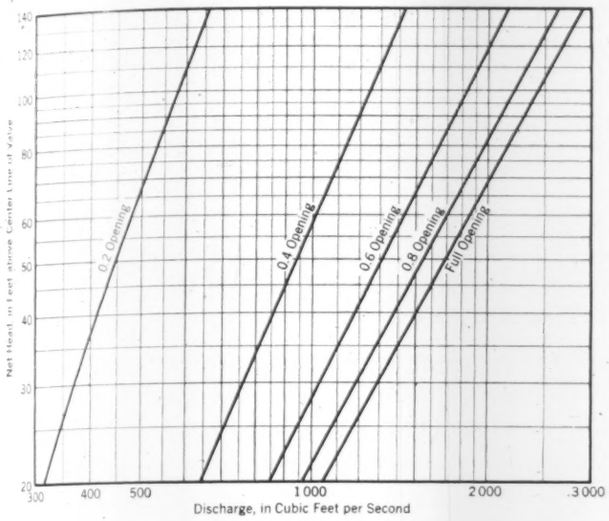


FIG. 3. HEAD-DISCHARGE RELATION FOR 84-IN. NEEDLE VALVE
From Tests on the Installation at Madden Dam

V is the velocity in the 138-in. diameter section just inside the entrance. Similarly the total loss in the pipe itself, including friction, and losses at the butterfly valve, at two changes in alignment, and in the upstream reducing section, amounted to $0.133V_1^2/2g$, in which V_1 is the velocity in the 102-in. diameter section.

Taking into account these losses, it was possible to derive empirical formulas for the discharge of the needle valves under a net effective head acting at the valve inlet. These relationships, shown graphically in Fig. 3, are applicable to identical valves in other settings. Losses at the entrance to the pipe and in the pipe itself must of course be determined separately to fit the particular case.

Mention should also be made of the mechanical tests made to determine the amount of torque required to close the butterfly valve. The valve is operated by means of a gear train, meshing with a gear segment mounted on the end of the upper stem of the valve leaf. The gear train is driven by a 7 1/2-hp electric motor, and the total gear ratio is 28,000 to 1.

At the highest head tested (114.2 ft) it was found that the motor torque remained practically constant at 20 lb-ft from the start of the operation to 60 per cent closure. Between 60 and 70 per cent closure the torque dropped from 20 to 16 lb-ft, and from 70 per cent closure to just before the valve began to seat, the torque increased to 26 lb-ft. Seating of the valve increased the motor torque to 48 lb-ft, equivalent to a torque of 1,344,000 lb-ft at the valve stem.

SLUICEWAY TESTS

Principal dimensions of the sluiceways are shown in Fig. 4. For testing purposes, a temporary wooden platform with a protecting shed (Fig. 5) was erected over the outlet of Sluiceway No. 3. A telephone line from the platform to the operating chamber inside the dam was used to transmit orders and information about gate operation.

Fifteen pitot nozzles were mounted on a streamlined steel frame installed in the sluiceway, 10 ft from the exit. Individual tubes led to a manifold connected to an altitude gage. Four piezometer openings were located in the walls about one foot further upstream, and were interconnected by means of piping which led to one leg of a manometer. The other leg of the manometer was open to the atmosphere. Tailwater elevations were read on a staff gage located in a zone of quiet water some distance from the sluiceways.

Tests covered the range of heads between 71.5 ft and 138.5 ft. At the highest head, the mean velocity through the sluiceway was 72.4 ft per sec. Values of C in the basic discharge formula, $Q = CA\sqrt{2gh}$, were found to vary inversely with the one-eleventh power of the head. The empirical relation derived from the test data was $C = 1.183\,H^{-0.089}$. (From this equation, $C = 0.93$ for $H = 15$, and 0.76 for $H = 155$.)

Since the tests were not carried below reservoir elevation 166.5, the extrapolation necessary for obtaining the discharge at low heads must be made over such a large range that the probabilities of erroneous results are considerably increased.

The theoretical discharges for the case where the res-

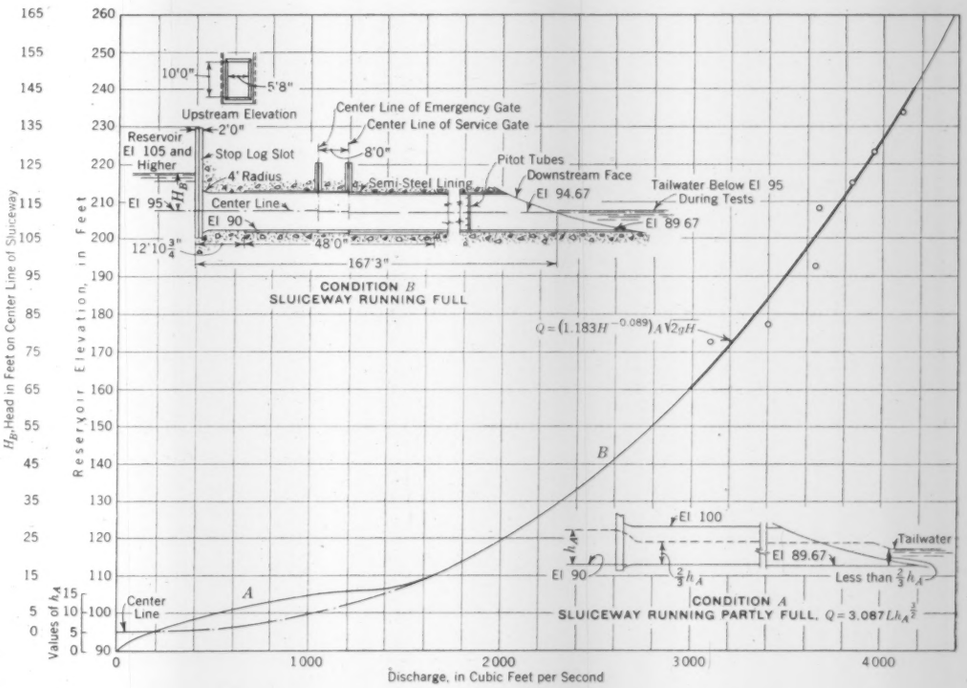


FIG. 4. HEAD-DISCHARGE RELATIONSHIP FOR MADDEN DAM SLUICEWAY
The Heavier Part of the Curve Indicates the Range Covered by Field Tests

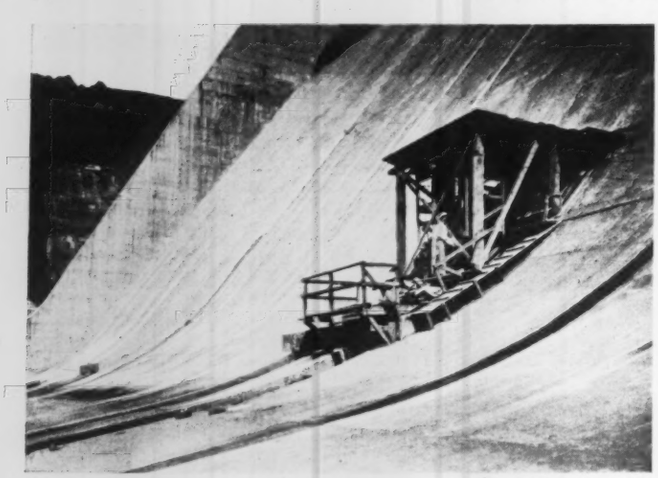


FIG. 5. PLATFORM ERECTED OVER SLUICEWAY EXIT TO HOUSE GAGE-BOARD

ervoir level is so low that the sluiceways do not run full, were computed by using the formula,

$$Q = 3.087\ LH^{3/2}$$

in which Q is the discharge in cubic feet per second; L, the width of sluiceway, in feet; and H, the head on floor of sluiceway, in feet.

This formula was used to calculate the discharges for one sluiceway operating under heads of from zero to 15 ft. The sluiceway is assumed to flow partly full throughout this range.

The entrance conditions, with the sluiceway flowing partly full, are assumed to correspond to those of a flat-crested weir, and the flow is assumed to take place in accordance with the principle of least energy, which requires the depth of water in the sluiceway to be two-thirds of the head above the entrance. Velocity of approach was neglected and, because of the low heads involved, it was considered that the entrance flare was sufficient to make entrance losses negligible.

In Fig. 4, the indeterminate range in which the sluiceway changes from partly full to full is represented by a short transition in the discharge curve.

Individual test points deviate considerably from the mean curve. The greatest irregularity is noted in the tests made at reservoir elevations 192.74 and 208.20. The cause of this particular discrepancy in results may be due to the fact that different test apparatus was used for taking the field data on these two tests. At reservoir levels below El. 200, the pressure in the piezometers was not enough to force the column up to the gage-board, and the water had to be drawn up by suction with a vacuum pump. The readings obtained by this method varied considerably and were not always consistent. With reservoir levels above El. 200, it was not necessary to use the vacuum pump, and it is noticeable that these tests show smaller deviations from the average.

A comparison between the results obtained by individual and collective readings of the pitot tubes gives no definite hint as to the comparative accuracy of the two methods. Over the entire range of heads tested, the difference between the two methods was always less than 1 per cent, and the discharges obtained by the individual method were consistently slightly lower. Since the discrepancy in results is so small the collective method, requiring less field and office work, seems preferable.

Some data have been obtained on sluiceways operating at partial gate openings, but they are not complete enough at the present time to develop satisfactory conclusions.

The tests described here were supervised by R. R. Randolph, Jr., associate engineer, under the direction of W. L. Hersh, engineer.

Conduct of Design for the Columbus Sewage Treatment Works

By ROBERT T. REGESTER

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ENGINEER, WHITMAN, REQUARDT AND SMITH, BALTIMORE, MD.

THE conduct of design for the activated sludge plant to be completed this year at Columbus, Ohio, embodied several features that office engineers on other projects should find of value. When the work described here was begun, studies establishing the general arrangement and over-all sizes of the various plant units had already been completed, and topographic surveys of the plant area had been made and plotted. The plant was to have a dry-weather capacity of 50 mgd, and its estimated cost was $3,400,000.

During most of the design period—about three years—the design force consisted of 20 men. The organization chart is shown in Fig. 1. One or two designing engineers or senior assistant engineers, as squad leaders, were given responsible charge of the work under each branch. In addition, one assistant engineer was selected to devote his entire time to the writing of specifications. The remaining men were not definitely assigned to the various branches, but were organized with flexible status.

In order to commence construction and to furnish maximum employment of labor as quickly as possible, it was decided to award contracts for principal parts of the project in successive order, rather than to award one general contract. After careful consideration, the project was divided into 24 contracts, including 15 for structures and 9 for equipment. A tentative sequence for these was likewise established, and this schedule, to a large degree, dictated the functioning of the design force.

Generally, the force functioned as two or three squads. Each squad varied in size and prepared a separate current contract, or the supplementary work for a contract which had previously been advertised for bids. The remaining squad leaders were detached to prepare concurrently the preliminary studies for contracts immediately to follow, or for those directly related to the work in progress. On several of the largest contracts, each of which required the attention of nearly the entire force, two or three squads executed major parts of the same contract.

Continuity in the preparation of contracts, which was of prime importance, was maintained by the policy of making the preliminary studies in advance. This permitted the assistant engineers and draftsmen of a squad completing work on any current contract, to shift without delay to the work of the succeeding contract. In such event, another squad leader who had prepared the

preliminary studies for the latter contract would then direct the work of the squad.

The sequence of design for the first six major contracts is shown in Fig. 2. The number of men engaged on each contract at any time is represented by the vertical scale. The diversity of work in progress simultaneously is evident, and the effect of work already awarded upon contracts in preparation at any time can be noted.

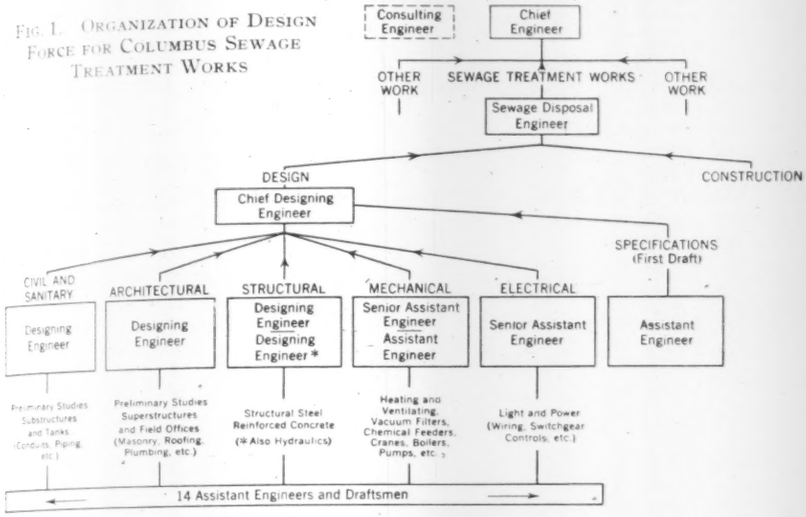


FIG. 2. ORGANIZATION OF DESIGN FORCE FOR COLUMBUS SEWAGE TREATMENT WORKS

For each contract, the preliminary study consisted principally of the preparation of drawings showing the tentative arrangement of the proposed structure. Overall dimensions were given, but structural design was considered from a general standpoint only. Frequently several alternative designs were prepared. In conference with the consulting engineer, final selection was made and revisions were suggested. Then the study drawings became the basis for the preparation of a contract. Also included in the preliminary study was the obtaining of information from equipment manufacturers. The required dimensions, weights, motor sizes, and so forth were thus known in advance of preparing contract drawings and specifications.

Concurrently with the preparation of contract drawings the necessary detailed design computations were made and checked. All computations were prepared on $8\frac{1}{2}$ by 11-in. sheets having printed black headings. Calculations of permanent value, including all final design data, were prepared on white sheets directly with black fountain-pen ink. Each squad leader was furnished with an individual looseleaf computation book, which had to be kept accessible at all times.

A high standard was set for contract drawings. They were prepared first with soft pencil on tracing paper, in order that prints could be obtained at various stages of completion, and were later traced with ink on cloth having printed border lines and partly blank title blocks.

To give prospective bidders complete information in convenient form, and to provide inspectors on construction with easily handled plans, these tracings were then lithoprinted on $8\frac{1}{2}$ by 11-in. paper for binding with the specifications. Some extra care in drafting was necessary to secure clarity in these small copies, which were approximately one-third the size of the originals. A complete set of standards for office practice was prepared and furnished to each man, thus relieving the squad leaders from the burden of trivial drafting detail and permitting their attention to be directed exclusively to design problems.

Except in the case of contracts for equipment, the work was bid as unit prices for stated estimated quantities. In both the specifications and the contract drawings, an honest effort was made to give the prospective bidder specific requirements for every detail of the work and to avoid ambiguity. Such attempt is reflected, no doubt, in the difference between the total bid prices of the lowest and next lowest bidders. On four major contracts, with low bids ranging from $267,000 to $858,000, this difference averaged only 4.5 per cent of the amount of the low bid. For the same contracts the maximum difference was 5.2 per cent of the respective low bid. The average difference thus demonstrated the sufficiency of the 5 per cent proposal bond required by the city.

SUPPLEMENTARY DRAWINGS PROVIDED COMPLETE DETAIL

Immediately after a contract was advertised, supplementary drawings giving complete data for minor details of the work were prepared and lithoprinted. About one-third of all the drawings completed were of this nature. They included steel-reinforcement placing diagrams and bending schedules, cast-iron piping diagrams and schedules, miscellaneous iron castings, and other special details.

The absence of steel reinforcement data from the contract drawings should be particularly noted. This omission adds greatly to the clarity of working drawings and renders them much easier to read. The separate reinforcement drawings were prepared on a scale of three-eighths inch per foot, with the structure outlines shown lightly and the bars indicated by heavy dashed lines. Only the limiting bars of a group having a constant spacing were shown, and the particular spacing was given. Of course, it was necessary to establish the location of most of the concrete construction joints on the contract drawings in order to properly detail the bars. However, the control of reinforcement rested entirely and directly in the hands of the designers. This procedure eliminated the possible loss of time from checking and revising shop details prepared by fabricators or others.

Bending schedules were usually issued to prospective bidders prior to the date for receiving bids. It is believed that the furnishing of these detailed schedules was largely responsible for the low bid prices received for steel reinforcement—averaging 2.8 cents per pound for re-rolled rail steel.

The cast-iron piping diagrams and schedules found considerable favor among the foundries bidding on the work, and also proved valuable aids to pipe installation. A separate diagram was prepared for each system of piping, showing the arrangement of pipes and fittings either "unfolded" and laid in a single horizontal plane, or arranged as an oblique view. Each fitting was symbolized, and shown in heavy solid lines; the connecting lengths of straight pipe were indicated as light dashed lines with center-line dimensions and elevations noted. Accompanying the piping diagrams were fitting schedules, and other supplementary drawings on which special fittings were completely detailed.

On equipment contracts, bidders were required to submit such outline drawings and descriptions as would enable the acceptability of any bid to be determined.

After the award of a contract, and at least 30 days prior to the commencement of manufacture, the contractor was required to submit for approval certified drawings and descriptions of all manufactured equipment and products, giving all data essential for checking conformity with the specifications, and for erection. Paper prints were first furnished in duplicate and when inspection of them indicated necessary changes or corrections, the procedure was repeated until satisfactory information had been submitted. When ready for approval, four copies of the drawings on cloth were required. These were retained for inspection, construction, and permanent records.

ANALYSIS MADE OF THE TIME REQUIRED FOR DESIGN

Daily time records (reported on monthly sheets) were kept by each man of the design force. Based upon the time records of 23 men over a period of approximately 15 months, these data are presented in Table I. The unit "man-day" refers to a 7-hour working day, with Sundays, holidays, and vacations excluded. Of course, some trial designs and penciled working drawings were discarded for various reasons; however, the time spent on such discarded work is included in the data given. This information provides a basis for proportioning a design force and for estimating the period of design. It should be remembered that the data apply to work of a complicated character, involving considerable mechanical equipment and piping, and not comparable to ordinary building work.

NUMBER OF CONTRACT DRAWINGS ROUGHLY ESTIMATED

It was frequently necessary to estimate in advance the dates when ensuing contracts would be ready for advertising. This in turn required an estimate of the number of contract drawings required. A review of several of the earlier contracts indicated that the cost of construction work actually shown per sheet of drawings would supply a suitable estimating basis. In the case of the aeration tanks and pipe gallery, only one-half the length of the symmetrical gallery and one aeration tank were actually shown, except on the location and general plans. Again, for the eight final settling tanks, only one tank was actually shown in detail. By determining the cost of what might be termed "the minimum unit of work actually shown" for any previous contract, and dividing this cost by the respective number of detailed drawings used, the cost of construction work shown per sheet was obtained. Such data, based upon the various contracts for which drawings have been completed, are summarized in Table II.

Preliminary estimates covering all parts of the project were available and, for a particular contract, were easily broken down to obtain the cost of the minimum unit of work to be shown for that contract. This cost, divided by the proper figure from Table II, gave the approximate number of contract drawings required.

Then, since the number of man-days required per drawing (Table I) and the probable number of men available for the particular work were known, it was possible to obtain an estimate of the design time for a contract in terms of actual working days and to adjust it to the basis of calendar days. Tables I and II can also be used for determining roughly the number of men required in an organization for designing work of similar character in a given time.

For all the design work previously described and completed to date (May 15, 1936), the salaries of the entire design force have amounted to approximately 3.5 per cent of the total actual cost of the work. It is believed that this cost was partly offset by the savings in the cost of construction resulting from complete detailing.

During the execution of design a splendid spirit of leadership was shown by Paul W. Maetzel, chief engineer; Robert A. Allton, M. Am. Soc. C.E., sewage disposal engineer; and the late John H. Gregory, M. Am. Soc. C.E., consulting engineer. The entire design force gave real cooperation and maintained an excellent esprit de corps. The construction force, under the immediate supervision of James H. Blodgett, Assoc. M. Am. Soc. C.E., chief field engineer, also cooperated to the fullest extent. For these helpful contributions in carrying out the design, the writer is greatly indebted.

[*Mr. Regester was formerly chief designing engineer, Department of Public Service, Columbus, Ohio.*]

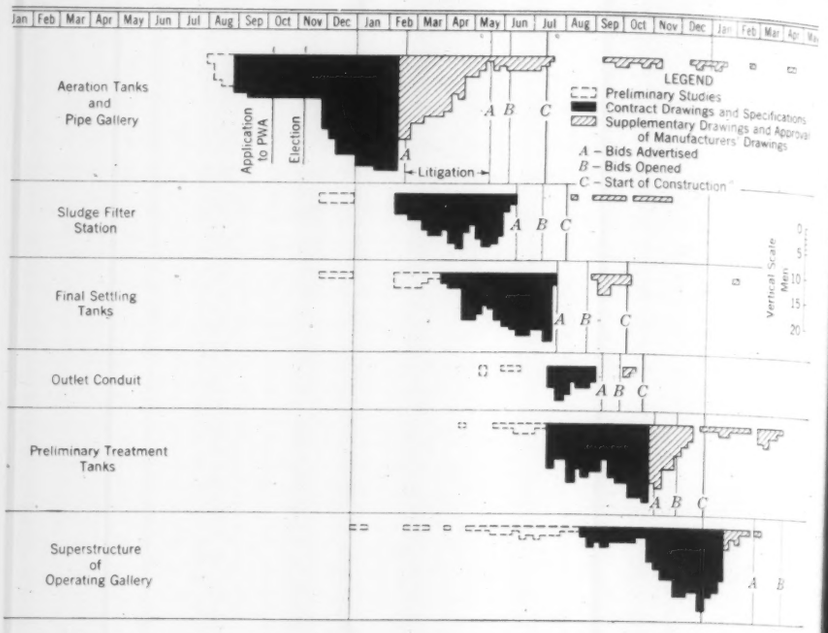


FIG. 2. SEQUENCE OF DESIGN FOR FIRST SIX MAJOR CONTRACTS Showing Flexibility of Organization

TABLE I. DISTRIBUTION OF TIME FOR DESIGN OPERATIONS

OPERATION	PER CENT OF TOTAL TIME	MAN-DAYS PER COMPLETED DRAWING
Preliminary study	4.9	1.2
Design computation	12.3	3.1
Penciled drafting	32.3	8.1
Tracing	27.2	6.8
Squad supervision and checking of drawings	11.9	3.0
Specification writing	4.8	1.2
Estimating quantities	4.7	1.1
Checking of manufacturers' drawings for approval	1.9	0.5
Total design time	100.0	25.0

TABLE II. COST OF CONSTRUCTION WORK SHOWN PER SHEET OF CONTRACT DRAWINGS

Substructures with tanks only	$5,600
Superstructures only	2,200
Entire buildings with tanks	6,800

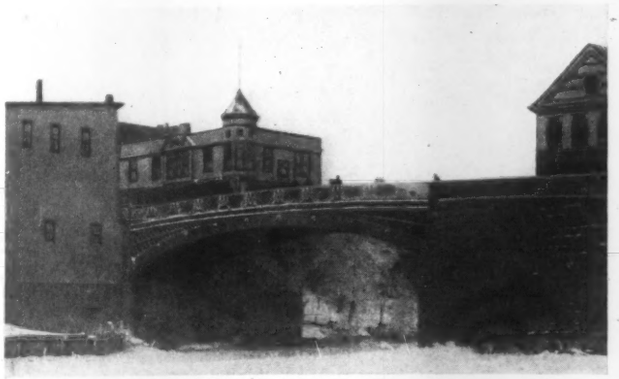
OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Some Early Bridge Structures

DEAR SIR: I was interested in the articles on bridges in the May issue of CIVIL ENGINEERING. The accompanying photograph shows a cast iron bridge at Brownsville, Pa. This bridge was built in 1836 by army engineers and is still in service. The structure has lately been strengthened to permit its use for transport trucks, but the old tubular arches of cast iron are still in place.

In 1923 a local chapter of the Daughters of the American Revolution erected a tablet on the structure. The inscription on this



©*Pennsylvania Department of Highways*

CAST IRON BRIDGE BUILT ACROSS DUNLAPS CREEK AT BROWNSVILLE, PA., IN 1836

plaque reads: "The first cast-iron bridge, built in the United States, was built in 1836–1839 over Dunlaps Creek at this point. This tablet was erected by the Colonel Andrew Lynn Chapter of the Daughters of the American Revolution of Pennsylvania, 1923."

An interesting suspension bridge 1,000 ft long was built in China in 58 A.D. by means of cast iron pillars and wrought iron chains (Tenengren's Memoirs on file at U. S. Geological Survey in Washington.) Who knows but that this was the first suspension bridge to be built?

Although the creation of cast iron is credited to Germany in 1400 A.D. and the blast furnace to France shortly after, recent researches indicate that we owe both to Confucius, the Chinese scientist and religious leader, who lived in the third century B.C. Iron objects cast many centuries before 1400 A.D. are constantly turning up in various Chinese temples.

RALPH M. SHAW, JR.
U. S. Pipe and Foundry Company

Burlington, N.J.
July 7, 1937

Improvements Reduce Sewer Maintenance

TO THE EDITOR: In his article on "Sewer Maintenance an Engineering Problem," in the March issue, Raymond R. Ribal, Assoc. M. Am. Soc. C.E., discusses a subject that has not received sufficient attention, in view of its importance in maintaining proper sanitary conditions and adequate drainage in our built-up communities and of its economic importance to the taxpaying public. In New York State it has unfortunately been the exception rather than the rule for even the larger municipalities to attempt any adequate engineering records of maintenance costs and practices that might be used in the preparation of a recommended policy in sewer maintenance work. Generally the maintenance of sewers has been placed under a branch of the Department of Public Works or the city engineer, with the result that sewer maintenance has largely amounted to taking care of complaints or the more urgent maintenance projects that were forced to the attention of municipal authorities.

In the general rules of eligibility established by the Washington office of the WPA in Circular No. 8, it was stated that, in order to make any municipal work or service eligible for operation on the basis of a proposed project, the application for it must contain the following statements: "Not a normal activity (or service) of the sponsor. No regular employees will be displaced."

While maintenance work on sewer systems is not eligible as a WPA project under this rule, there is hardly a municipality in New York State that has not taken advantage of the federal aid available to correct some of the deficiencies in its sewer systems that have been responsible for heavy maintenance costs. This type of work has been favored by the WPA authorities during the winter months, when many other types of construction projects could not be carried out advantageously. As state consultant on sanitation to the WPA, I have encouraged these projects, and a large number of them have been carried out. I believe that a brief summary of the accomplishments with WPA aid in New York State during the past year in the field of sewer and sewage-treatment plant construction, will be of interest. The following estimate on employment and earnings, furnished by Paul R. Byrnes, of the office of the New York State Administrator of WPA, shows the total wages expended on sewers and sewage treatment from August 1935 through November 1936 to be $11,814,463.

A few of the New York State sewer projects operated under the WPA during the past year will be mentioned. Complete sewer systems and sewage treatment plants have been completed or are now under construction at the villages of Lake George, Falconer, Honeoye Falls, and Pittsford. These will eliminate serious potential public nuisances and menaces to health, which have long been recommended for correction by the State Department of Health.

One of the most serious threats to public health existed in the serious pollution of Ley Creek, resulting from the discharge of raw or partially treated sewage from sixteen communities. For several years the State Department of Health had recommended the construction of an intercepting sewer and sewage treatment plant to intercept and treat the sewage of the municipalities on the watershed of the creek. The construction of the so-called Ley Creek intercepting sewer and sewage treatment plant was finally authorized by the Onondaga County Board of Supervisors to be undertaken with WPA aid. The estimated cost of this work is in the vicinity of $2,300,000. As of November 1, 1936, a total of $1,200,000 of federal funds had been expended, and $135,000 had been expended by the county. The intercepting and trunk sewers are nearly completed, and work was started some months ago on the construction of a complete activated-sludge treatment plant.

One of the WPA projects undertaken in Syracuse was the cleaning and renovating of the existing sewer system. Similar projects have been carried out by the WPA in Watertown, Auburn, Utica, Oneida, and Dunkirk, and some 22 WPA sewer projects have been completed in the city of Buffalo. WPA has also been responsible for the construction of a number of storm and sanitary sewers in the city of Niagara Falls, and for ten miles of sewers in Poughkeepsie. Similarly, relief sewers have also been constructed in the cities of New Rochelle and Gloversville.

EARL DEVENDORF, Assoc. M. Am. Soc. C.E.
Associate Director, Division of Sanitation, State Department of Health

Albany, N.Y.
June 19, 1937

Many Society Members in Civil Engineer Corps

DEAR SIR: On page 369 of the May issue of CIVIL ENGINEERING there is an item commenting on the fact that eleven of the fifteen men who passed the examination for commission in the Civil Engineer Corps of the Navy are Juniors in the Society. This is just another example of the close connection between the Society and the Corps.

Of those now on the active list, the one rear admiral is a Member; of the twelve captains, ten are Members, one is an Associate Member, and one is a non-member; of the twenty-one commanders, eight are Members, five are Associate Members, and eight are non-members; of the forty-four lieutenant commanders, ten are Members, eleven are Associate Members, and twenty-three are non-members; of the twenty-five lieutenants, two are Associate Members, four are Juniors, and nineteen are non-members; of the nine lieutenants, junior grade, four are Juniors. Exactly one-half of the one hundred and twelve on the active list of the Corps belong to the Society, the representation among the higher ranking officers being particularly large.

Of these officers, one has been in the Society for thirty-seven years; five have been Corporate Members for thirty years; and six have been full Members for more than twenty-five years.

Among the retired officers of the Corps, the record is still better. The two rear admirals, the five captains, and one of the three lieutenant commanders are Members. One joined the Society in 1890, and all the Members have held that grade for more than twenty-six years.

One member of the Corps, the late Rear Admiral M. T. Endicott, was a Director of the Society and then, in 1911, President. One of the retired officers is now a Vice-President of the Society. Another retired officer, when on active duty in 1907, was awarded the Norman Medal.

WALTER H. ALLEN, M. Am. Soc. C.E.
Captain (CEC), U. S. Navy

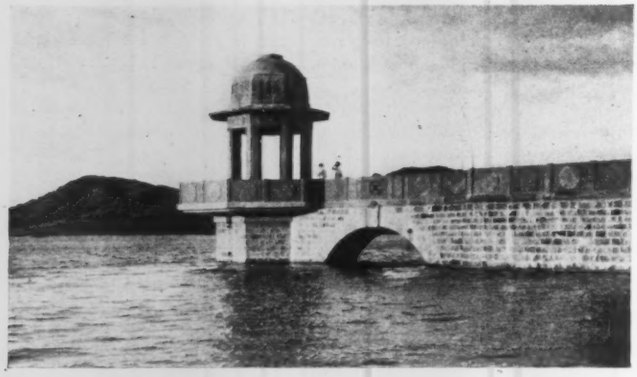
San Francisco, Calif.
June 27, 1937

Design of Reservoir Outlet Tower

TO THE EDITOR: Readers of CIVIL ENGINEERING may find the structure illustrated in the accompanying photographs to be of interest. These show the outlet control tower of the Umed Sagar Reservoir, constructed in 1933 to augment the water supply of the city of Jodhpur in Rajputana, India. The dam is of the composite type, consisting of a masonry corewall carried down to rock level, with an earthen embankment on each side.

The local topography is rugged and severe, with bare rhyolite hills. For esthetic reasons all auxiliary structures were designed to be in harmony with the surroundings. The outlet tower lent itself particularly well to severe treatment, while at the same time permitting the incorporation of local architectural design features.

The shaft of the tower, which is 43 ft high, has an internal diameter of 8 ft, and is hexagonal on the outside. It is built of rhyolite stone of a blue-gray color set in cement mortar. The arch ring of the approach bridge and all work above the rhyolite masonry, with the exception of the reinforced concrete overhanging platform, are carried out in red Vindhyan sandstone carved by local masons. The canopy, known locally as a "chhattri," is frequently found in the architecture of Rajputana, being used extensively in the construction of tombs and memorials.



GENERAL VIEW OF OUTLET CONTROL TOWER OF THE UMED SAGAR RESERVOIR

LOCAL ARCHITECTURAL INFLUENCES ARE APPARENT IN THE TOWER DESIGN

Since the reservoir bears the name of the ruler of the state, who contributed privately to the cost of constructing the reservoir, it was thought appropriate to incorporate the coat of arms of the ruling family. This appears on a shield facing the approach and placed just above the projecting course above the supporting columns; below this course and carved on the lintels between the supporting columns are symbolical fish, while on the deep band above the projecting course are carved ripples, symbolical of water.

The structure complete, with five valves of 18-in. diameter and operating pillars, cost the equivalent of $4,900. I was responsible for the design and construction of the project, except for the architectural treatment which was carried out by G. A. Goldstraw.

F. F. FERGUSSON, Assoc. M. Am. Soc. C.E.
Senior Executive Engineer,
Public Works Department

Jodhpur, India
June 11, 1937

Comparative Accuracy of Topographic and Stereotopographic Contouring

TO THE EDITOR: With reference to the article on "Air-Mapping the Brazos River Area" by Eric Haquinius, M. Am. Soc. C.E., in the July issue of CIVIL ENGINEERING, my experience may be of interest.

In connection with the development of Mother Neff State Park (which has an area of about 250 acres, with 1,400 ft of frontage on the Leon River, and extends a mile and a half back from the river, its elevation being between 588 in the river channel and 790 at the top of the hill), we made a topographic map of the park area, after a stadia survey. The scale was 100 ft to the inch, and the vertical interval 2 ft. About two-thirds of the park is quite rough and covered with heavy timber and cedar brake, and the rest is rolling, open prairie.

While checking the culture on the map of this section, which was made by the methods described by Major Haquinius (scale 1,000 ft to the inch, vertical interval 10 ft), we compared the positions of the contours with those on the park map and found that they checked throughout, as closely as we could scale them.

WALTER K. ADAMS, Assoc. M. Am. Soc. C.E.
Senior Foreman, National Park Service

McGregor, Tex.
July 8, 1937

SOCIETY AFFAIRS

Official and Semi-Official

Fall Meeting Program Plans Complete

Boston to Entertain Society and Engineering Institute of Canada Jointly, October 6–8, 1937

THOUGH the Annual Convention at Detroit ended less than a week ago, plans for the Fall Meeting at Boston are already thoroughly matured. And a preview of the program gives assurance that in several respects this Fall Meeting will be of unusual interest.

First, the meeting is to be a joint one of the American Society of Civil Engineers and the Engineering Institute of Canada. A large delegation of engineers from north of the St. Lawrence will be in attendance, and their organization will have complete charge of one of the sessions.

Harvard Film Service

HARVARD HOUSES ON CHARLES RIVER

Second, the newly formed Soil Mechanics and Foundations Division is scheduled for its first formal appearance on a Society Meeting program, and will present a full day of technical papers covering a wide field of practical problems.

Third, the Engineering-Economics and Finance Division has provided a symposium of three papers dealing with the economics of public works construction.

Five other Technical Divisions have also arranged sessions, and the Northeastern Section, host for the occasion, has planned a variety of social events to round out the program.

At the opening session, Wednesday, October 6, President Conant of Harvard and President Compton of the Massachusetts Institute of Technology will give brief addresses, and Walter Gropius, the distinguished German architect recently appointed to the chair of architecture at Harvard, will speak on "The Cultural and Technical Background of the 'New Architecture.'" The afternoon session will be conducted by the Engineering Institute of Canada, and three papers by members of the Institute will be presented on bridge building, port construction, and power development:

"The Substructure of the New Highway Bridge Over the Fraser River at New Westminster, British Columbia"
"Recent Developments at the Port of Halifax"
"Power Development at Comeau Bay, Quebec"

Following the customary arrangement, the second day of the meeting will be given over to technical sessions. The Soil Mechanics and Foundations Division offers a symposium of four papers, presentation and discussion of which will occupy the entire day:

"Applications of Soil Mechanics to Design of Levees in the Lower Mississippi Valley"
"An Investigation of the Stability of Embankment Foundations"
"Application of Soil Mechanics to Building Foundations"
"Review of the Science of Soil Mechanics, Outlining in Particular, Tests and Studies Now in General Use"

Two of these papers dealing with soil mechanics problems, and two others, entitled "The Quabbin Dike Built by Hydraulic Fill Method" and "Studies to Predict Building Settlement," will appear in the September PROCEEDINGS, and therefore will be available for study before the meeting. The symposium will be followed by a general discussion of "Methods of Boring and Sampling."

At the half-day session of the Sanitary Engineering Division, the following papers will be presented:

"Studies of the Pollution of Boston Harbor and Its Tributary Waters"
"The Decomposition of River Deposits"

Concurrently the Surveying and Mapping Division will hear papers on:

"Land Registration in Massachusetts"
"Establishment of the Massachusetts System of Rectangular Coordinates"

In the afternoon the Waterways Division will take up three matters of particular interest to engineers in the coastal states:

"Recent Developments in Marine-Borer Studies"
"Repairs of the Substructure, Army Supply Base, Boston"
"Reconstruction of the Footings of Commonwealth Pier 5, Boston"

Discussion of the economics of public works construction should attract a large attendance at the session of the Engineering-Economics and Finance Division. Its program includes:

"Hazards of Uneconomic Public Works Construction"
"Engineering-Economics and Public Opinion"
"Economic Advantages of Orderly Planning of Public Works"

Finally, the City Planning Division announces a session that will include a paper and one or more discussions on "The Value of a Thoroughfare Plan and Its Relation to Metropolitan Park Systems Serving Urban Areas," and other papers on certain phases of state planning.

The technical sessions will be completed on Thursday, and Friday morning will be devoted to inspection trips, the principal ones being to Harvard University and the Massachusetts Institute of Technology, where laboratories of particular interest to civil engineers will be visited. For those not caring to visit the laboratories, special arrangements will be made to visit Harvard's celebrated "Glass Flowers," the Widener Library, and other features. Both groups will meet at M.I.T. later in the morning for a showing of "high-speed" motion pictures.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

As an alternative to the laboratory inspections, a special bus trip may be taken along the North Shore, visiting Revere Beach, Nahant, and Marblehead.

All these trips on Friday morning, which have been planned to include the ladies as well, will terminate at the New Ocean House at Swampscott, Mass., where a get-together shore dinner will be

served early in the afternoon. The remainder of the day will be devoted to recreation on the grounds of the New Ocean House, where facilities are afforded for dancing, cards, tennis, golf, and bathing (for any hardy souls who will venture into the ocean in the month of October).

In addition to these formal trips, several optional all-day trips by private cars will be arranged to visit engineering projects, provided a sufficient number desire to attend. Objectives include the Cape Cod Canal, where many improvements have recently been made, and the Quabbin Dam of the Boston Metropolitan Water Supply project, now under construction.

The Ladies' Entertainment Committee has arranged a number of interesting affairs for the ladies while the members are attending the technical sessions. These include a trip on Wednesday afternoon to Fenway Court, the Isabella Gardner Museum, where they will have an opportunity to see an unusual exhibition of works of art. On Thursday the ladies will go by motor coach to the Wayside Inn, an old-time hostelry made famous by Longfellow. After luncheon at the Inn, the party will visit the historic towns of Concord and Lexington.

The ladies will join with the members in the other social events throughout the Fall Meeting. On Wednesday there will be an evening entertainment in the ballroom of the Statler Hotel, the details of which are being arranged by the Entertainment Committee. The program on Thursday includes a dinner at the Hotel at which Professor Robert E. (Tubby) Rogers of M.I.T. will be the speaker. Dancing will follow the dinner, with music by a well-known orchestra.

For students, there is to be an interesting innovation. In lieu of the usual Student Chapter conference, a luncheon will be given on Wednesday, immediately after the opening session of the meeting. An attendance of about 200 is expected.

Not the least attractive part of the Fall Meeting will be its setting. New England is at its best in autumn; the Weather Bureau records of 50 years are almost a guarantee of sunny days, and the temperature is ideal for golf and mountain tramping. Above all, the autumn coloring of the hills is perhaps unsurpassed anywhere in the country.

All things considered, the Northeastern Section is offering a fine prescription for a quick build-up after the hot months of summer: "Come to Boston, October 6–8, for the Fall Meeting, and stay with us at least over the week-end."

The complete program of the Fall Meeting will be published in the October issue of CIVIL ENGINEERING.

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Applications for Membership in the Society Are Above 1936 Level

APPLICATIONS for admission to the Society during the current year totaled 773 as of July 13, 1937, the last date for which figures are available. This is 6 per cent in excess of the total for the corresponding period in 1936, and some 35 per cent better than the figure for 1935. Applications for transfer during the current year have reached 200, which is 18 per cent higher than last year's July 13 total.

Though summer may be the slack season for many, it is the rush period for those of the Headquarters staff concerned with membership. Beginning early in June, they are literally swamped with the applications of recent graduates who wish to take advantage of the provision for remission of the first year's dues; and the flood continues until early in September. This year, in the single week beginning June 8, the applications totaled 101, and in the following four weeks, 272 were received. The latter figure is 10 per cent greater than last year's for the same period.

The membership roll itself reflects a relatively slow but nevertheless steady growth. During the 12 months preceding July 13, 1937, additions exceeded deaths and resignations by 120, an average net gain of one member every three days throughout the year.

More About Regional Conference of Virginia Student Chapters

FOLLOWING a custom of several years' standing, the University of Virginia took its turn as host to a regional conference of the Virginia Student Chapters on March 27, 1937. There were present 60 men from Virginia Military Institute, 20 from Virginia Polytechnic Institute, and the full membership of the Chapter at the University of Virginia, together with members of the respective faculties, members of the Society, and guests.

The morning was devoted to short talks by John L. Newcomb, M. Am. Soc. C.E., president of the University of Virginia; Walter Rodman, dean of the University's Engineering School; E. M. Hastings, M. Am. Soc. C.E., chief engineer of the Richmond, Fredericksburg and Potomac Railroad, and a member of the Society's Committee on Student Chapters; and Donald H. Sawyer, M. Am. Soc. C.E., a former Vice-President of the Society and now a member of the Procurement Division, U. S. Treasury Department, Washington, D.C. Colonel Sawyer spoke on "Opportunities for Engineers in Government Service." The session was conducted by T. H. Evans, Assoc. M. Am. Soc. C.E., Faculty Adviser of the University of Virginia Chapter.

The afternoon session was devoted entirely to student affairs. One student paper was presented from each of the three Chapters, followed by a round-table discussion in which all participated. The liveliest discussion took place over a topic in engineering education, "The Five-Year Versus the Four-Year Engineering Course." There was also discussion on "Specialized Versus General Engineering Education," and "The Best Type of Student Convention."

A tea dance followed the adjournment of the afternoon session and was enthusiastically attended.

The regional conferences of Chapters in Virginia have always been interesting and lively, but comment on the last convention was particularly complimentary as to the reduction in the number of technical and lecture-type papers, and increased emphasis on social events, which gave the visitors an opportunity to get better acquainted.

Columbia Scholarship Open

THROUGH the courtesy of Columbia University, New York, N.Y., the Society has at its disposal a scholarship in civil engineering covering tuition fees and dormitory accommodations, and including an allowance of $100 for books and incidentals. Its total value is about $700.

This scholarship is now open for the year 1937–1938, and applications should be filed without delay. Applicants must submit credits covering at least the first two years of an engineering course at an accredited school. The award is in the hands of a committee of the Society, subject to the approval of the university authorities, and may be held by the recipient for from one to three years, depending upon the class he enters at the university.

All necessary details, and instructions on the form of application, will be supplied on request to Society Headquarters.

The Detroit Convention Gets Under Way

MEMBERS of the Society are gathering in Detroit from all directions to attend the Sixty-Seventh Annual Convention, as this issue goes to press. Fewer papers are scheduled for delivery at the technical sessions than in some recent meetings, and more time and attention can therefore be devoted to each of the subjects under discussion. In addition, a most attractive series of social events, excursions, aud entertainments has been arranged.

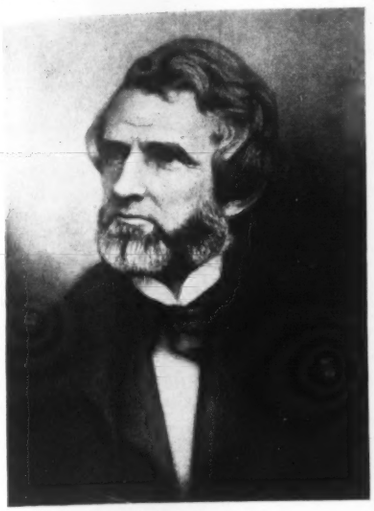
Forthcoming numbers of CIVIL ENGINEERING will carry a detailed account of the summer Convention and abstracts of all the technical papers presented.

Early Presidents of the Society

Readers are invited to contribute photographs, personal anecdotes, and engineering data for use in this series of sketches. Succeeding installments will treat of Thomas Coltrin Keefer, Max Joseph Becker, William Powell Shinn, and Octave Chanute.

XVII. WILLIAM EZRA WORTHEN, 1819–1897
President of the Society, 1887

IN THE EYES of the layman, William Ezra Worthen could never have been an "important" engineer, for it was not his lot to project any of the great works of internal improvement that challenge public admiration. Even an engineer, searching in 1937 for facts about his career, may at first be puzzled as to just why he achieved such outstanding professional honors as the presidency and honorary membership of the Society. Only gradually does one come to realize that, directly or indirectly, the work of William Ezra Worthen affected a multitude of people. From his early days at Lowell, measuring the flow of water at the Merrimac Mills, to his final engagement in Brooklyn as engineer of the Commission on Rapid Transit, he was continually rendering, in an unobtrusive way, "that essential service toward the furthering of enterprise, without which the best conceived projects would prove abortive."



WILLIAM EZRA WORTHEN
Seventeenth President of the Society

When Worthen was three years old, his father moved from Amesbury, Mass., to Lowell, to become the first superintendent of the Merrimac Mills. He was, in fact, one of the projectors of Lowell as a center of manufactures. The boy, from his earliest years, had therefore a special opportunity to wander about the mills and watch them in construction and operation, and was fascinated by their every feature.

About the time that James Bicheno Francis came to Lowell as a draftsman, young Worthen was entering college at Harvard. He was graduated from that institution in 1838, and returned immediately to Lowell to take up, at 19, the profession of civil engineering. Francis had by then become engineer for the Proprietors of Locks and Canals, and under him Worthen gained much of his early practical training in general hydraulic and mill work.

But the younger man was not content to devote himself to one branch of the profession, and in 1840 he went to work on the Albany and Stockbridge Railroad, under G. W. Whistler. He began with the preliminary surveys and remained until the completion of the road. During its construction, a seven-mile section was under his immediate charge.

He then returned to Lowell, and after assisting Francis in the construction of the famous Northern Canal in that city, set out on his own as a designer and builder of dams and mills. His first project was at Suncook, N.H., and another one of importance was the Boston Manufacturing Company's installation at Waltham, Mass. Of the latter mills and machine shops he was for a time in charge, as acting superintendent.

Up to about 1840, mills had been of nearly a stereotyped form and size (50 by 150 ft) and were operated solely by water power. A few of them were heated by steam, supplied through 3 to 6-in. cast-iron pipes suspended from the ceilings, but more commonly the heating units were hot-air furnaces, one in a little annex at each end of the building. Worthen's description of them throws light on the state of the art:

"The furnaces were cast-iron boxes with corrugated top and sides cast in one piece, and of length to admit cordwood of the usual 4-ft lengths. . . . [They] were enclosed in small brick buildings, arched over in brick, and . . . covered with sheet lead. As the lead expanded from the heat . . . it hung down from the eaves in fringes, and as it had not cohesive strength to draw the fringes back in cooling, they hung there till cut off from time to time. Eventually the lead parted at the ridge, like many financial schemes in which the construction account is kept open, declaring dividends from apparent surplus. . . ."

Beginning about 1840, mills began to grow in size and to be improved in mechanical equipment. Those designed by Worthen belong to this period and reflect many innovations. For example, supplementary steam power was introduced, and the boilers for heat and power for several mills were concentrated in one building and put in the hands of efficient stokers. One of the first of these was the Hamilton Mills (1845) at Lowell, which together with the Suffolk, Tremont, Lawrence, and Appleton mills in the same city were built by Worthen.

Some years later (1866), Worthen carried the idea still further by recommending to the Merrimac Manufacturing Company, at Lowell, the use of high-pressure steam for power, and application of the exhaust steam through a system of low-pressure pipes, for heating the entire works, which covered about 20 acres. The plan was adopted with success.

These developments were actually the forerunners, by almost a generation, of modern steam central heating. They prompted the late Charles E. Emery, M. Am. Soc. C.E., to the following comment (1891):

"Steam heating, considered simply as a business, has been practiced with some measure of success by every steam-fitter throughout the country, but such business is really founded on scientific principles worthy the efforts of engineers of talent who have had the best opportunities. This is shown by the results accomplished [by Worthen and his associates] long before steam-fitting as a business became established, and it will be seen that recent efforts are but modifications of the developments so thoroughly worked out years ago in the eastern mills."

When Worthen was about 30, two other engineering fields attracted his interest. He came to New York City and engaged in architectural work. Among his buildings were a bindery for the Appleton Publishing Company, and the complete works of that company at Williamsburg. At the same time he edited several mechanical publications, among them Appleton's *Cyclopædia of Drawing*, a comprehensive treatise which went through many editions.

The following years included such a variety of engagements that it is only possible to touch briefly on a few of them. His services were in general demand for many years for the selection and testing of pumping engines for water works, and he also designed many such engines himself—among them the first one for the high-service reservoir of the Old Croton Aqueduct in New York City, and several for James Pugh Kirkwood at Cincinnati and St. Louis. He also devised the floating grain docks which Kirkwood used at the Jersey City depots of the Erie Railroad Company.

His quickness in technical analysis, power of rapid generalization, and originality, coupled with a positiveness that silenced all opposition, quickly won him fame as a consulting engineer. Though he completed few projects himself, he was called on repeatedly to examine and report on water works, docks, and power projects over a territory that extended from the east coast to Minnesota and Missouri.

In 1866 the New York Legislature established the Metropolitan Board of Health, and Worthen became its engineer. In its four years of life, this board had under its jurisdiction practically everything that could conceivably have any effect on the health or safety of the population. It was really a sort of combination building-code authority, sanitation department, and health department, with a number of other services thrown in for good measure.

Worthen was called on, for example, to design a new public market, to assemble and distribute life-saving apparatus along the waterfront, to design chimneys that would help to abate the smoke

nuisance, to find means for odor control, to improve drainage, order street repairs, inspect tenements both for structural defects and plumbing deficiencies, and examine and approve plans for new construction. To add to the complications, an epidemic of Asiatic cholera swept the city just as the board was getting under way. All in all, Worthen was probably inclined to mark down the period 1866–1869 as the busiest of his life.

Later engagements included a brief period as chief engineer of the Chicago Main Drainage Canal (in 1891, just before actual construction began), and service as engineer of the Commission on Rapid Transit in the annexed district of the City of New York (Brooklyn).

What of the man himself? He has been described as possessing an overflowing vein of wit and humor. In this connection John H. Myers, M. Am. Soc. C.E., tells the story of a visit he paid as a young man to Worthen, on which occasion a question arose about a dam the latter had built on the Bronx River. "That is a pretty good dam," Worthen remarked, with a twinkle in his eye. "If it were part of the Croton water system, there would be a man employed to watch it." (The dam is still in existence, near 180th Street and Boston Road, the Bronx.)

In his presidential address, Worthen expounded his concept of the engineer which, though it may be open to criticism, is worthy of study:

"A true engineer," he said, "is as much born as a poet or any other artist, . . . [but] he is cradled on palpable material and nursed on facts, not metaphysical ideas. . . It is not necessary for him that he should believe either in the corpuscular or the wave theory of light. . ., or even that bodies fall by attraction of gravitation or by some later discovered force. If these present theories enable him to recollect facts, they serve their purpose. It is sufficient for the engineer to know the laws of force to be able to resist or use them; $V = gt$ or $V^2 = 2gs$ supplies him with the laws of gravitation even if he cannot understand the why."

Another excerpt from the same address is of interest in the light of current controversies: "From the position of the engineer as umpire between the capitalist and contractor, and his large employment and familiar intercourse with mechanics and laborers, he would naturally be the proper party to adjudicate in disputes between labor and capital, and perhaps it would be so were the present troubles between labor and capital. But the strife is to see whether labor cannot support another class: chapters, presidents, officers, walking delegates and the like. These troubles come up in every country and in every age; they are like the measles, whooping cough, fever, cholera. . . . Ours, at present, is an imported disease; the diagnosis of the suppression of the individual, of boycott, etc., is entirely un-American. It is not our own labor, but the imported labor that is striving, not for a chance for labor, but rather for a life without labor. There is no country in the world where labor is so well paid, well clothed, well fed, and well housed."

All of this is not to imply that Worthen was a foe of organized labor. In fact, he hastened to forestall that accusation in his next sentence: "Syndicates of labor are as proper organizations as syndicates of capital or of employers, and syndicates can only be met by syndicates. Properly organized, they are not expensive and are efficient. But," he concluded, "individuals should have perfect freedom to do as they please with their labor or capital within the limits of law, and must be protected by law and a healthy public sentiment."

Worthen entered the Society in 1867, became its President in 1887, and was elected to honorary membership in 1893. He died on April 2, 1897, at his home in New York.

Papers Filed in Library

ATTENTION IS CALLED to the following papers, which have been contributed to the Society for filing with the Engineering Societies Library, 29 West 39th Street, New York, N.Y. Charges for photostating will be quoted by the latter organization on request.

HYDRAULIC MODEL STUDIES

BARNES, GEORGE E., M. Am. Soc. C.E., "Report on Hydraulic Model Studies for the Charles Mill Dam" (42 pages of text, plus 50 plates of drawings and photographs); same, for Dover Dam (30 pages of text, plus 60 plates); same, for Mohawk Dam (35 pages of text, plus 58 plates); same, for Pleasant Hill Dam (50 pages of text, plus 77 plates); same, for Mohicanville Dam (20 pages of text, plus 36 plates). The model studies described in these reports were conducted by the Case School of Applied Science, for the District Engineer, Zanesville, Ohio. The dams are all included in the Muskingum Watershed Project. Each report includes a description of the hydraulic and operating requirements of the dam under consideration, an outline of the test procedure, detailed discussion of the tests, analysis of the data, a separate discussion of "findings of general interest," and conclusions and recommendations. Very briefly, the individual problems may be summarized as follows: Charles Mill—discharge conduits, stilling basin, spillways. Dover—outlet works, spillway. Mohawk—gate structure, tunnels, stilling basin. Pleasant Hill—intake tower, shaft spillway, tunnels, stilling basin, temporary diversion works. Mohicanville—intake structure, conduits, stilling basin, spillway. The general procedure involved testing models built in accordance with preliminary designs, developing improvements in those designs, and obtaining detailed data (such as discharge curves) on the performance of the final models.

SLOPE DEFLECTION

GOLDBERG, JOHN E., Jun. Am. Soc. C.E., "Analysis of Symmetrical Two-Column Bents by Slope-Deflection" (about 1,500 words, plus 2 figures). A simplified procedure is outlined for analyzing a symmetrical two-column bent under transverse loading. Joint and bent equations of the basic analysis are combined to obtain a series of equations, one for each story of the frame, which are solved by converging approximations.

RAILROADS IN THE 1850'S

PURDON, C. D., M. Am. Soc. C.E., "Railroading Sixty Years Ago" (about 6,000 words). This paper was read before the Engineers' Club of St. Louis in 1913, and was published in the *Journal of the Association of Engineering Societies*, February 1914 (the complete February issue of the *Journal* is filed). It consists largely of extracts from Executive Document No. 78, 2nd Session, 33rd Congress, which was a 13-volume report prepared in 1855 on explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Accompanying the *Journal* are 10 typewritten pages recently prepared by Mr. Purdon listing the contents of each volume of the 1855 report. It is presented with the thought that the original report is a valuable historic record, giving "a good description, in all respects, of the country and its resources, between the Mississippi River and the Pacific Ocean, around 1850." In addition to the railroad route surveys themselves, the report contains notes on geology, botany, zoology, soil, climate, and so forth; 246 excellent lithographs from sketches made on the ground; 373 plates of engravings (mostly zoological, and sketches of Indians); and many woodcuts. The new table of contents will be of value in historical research, for the report itself is inadequately indexed.

In and About the Society

THE SOCIETY was represented by Ivan E. Houk and Arthur Ridgway at the meeting of the American Association for the Advancement of Science, in Denver, June 21 to 26. They report that a number of papers of particular interest to civil engineers were presented, among them two on transmountain diversions of water supply and several on the scientific aspects of air transportation, particularly from the standpoint of weather conditions. An extensive program was also sponsored by the Hydrology Section of the American Geophysical Union, comprising papers on rainfall, snowfall, flood forecasting, reservoir silting, underground water supplies, and similar subjects. Arrangements are being made to publish the latter group of papers in the Union's *Transactions*.

* * * *

ATTENTION is again called to the fact that there is to be no August issue of PROCEEDINGS, the schedule having been revised so that that publication now appears monthly from September to June, inclusive, instead of from August to May, as in former years.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State and Local Engineering Societies Located in 40 States

CONSERVATION OF RIVER RESOURCES

IT IS encouraging to observe in the President's recent river-conservation message that the protection of the country's water resources is at last receiving authoritative recognition. The experience of recent years shows that we know too little about rivers for any comprehensive planning on such a scale without much study and more data. It is true that the National Resources Committee has only recently completed a drainage-basin survey, but the very engineers who made that survey say that it is only a preliminary for a further investigation.

Realizing that we face urgent problems of conservation, of water allocation, of purification, of floods, of water supply, and in a lesser degree, power and navigation, it is believed that the most practical approach to these problems may be made through boards set up to deal with each river basin as a whole. A board of local membership should be able to accomplish useful results at an early date. Its work could be coordinated with regional activities and given businesslike attention.

Council's committee on the conservation and utilization of natural resources is seeking all available engineering opinion and factual evidence regarding the need for more hydrological and unique data. At the moment, however, it seems to be best to leave control and regulation out of the planning for river valleys and devote more time and thought to education.

NATIONAL RESOURCES COMMITTEE

The present report, "Drainage Basin Problems and Programs," prepared under the supervision of the Water Resources Committee of the National Resources Committee, describes the principal water problems of each of the drainage basins and presents specific recommendations for construction and investigation projects with priorities of importance and time. Three principal aspects emphasized in connection with the program are:

1. The report does not suggest any particular rate of public construction expenditure. It suggests an orderly integrated plan of construction and investigation, which may be carried out over a period of years.

2. The listing of projects having local interest primarily does not indicate that federal funds should be used for their construction. The listing means only that the project is believed to fit into an integrated drainage basin program.

3. The National Resources Committee is not responsible for carrying out any of the recommended work; it is not an administrative agency. The work suggested, if carried out, will be through the normal channels of existing federal, state, and local agencies. The report is based on an intensive study by a special organization established by the Water Resources Committee, which worked in close cooperation with state planning boards as well as with all federal agencies concerned with water problems.

Projects are classified in the following groups: Group A is ready for construction and should be undertaken as soon as possible. Group B, while desirable, can have priority definitely determined only after additional studies. Group C should follow Group B in sequence. The estimated cost of the projects in Group A is $1,727,000,000; in Group B, $1,034,000,000; and in Group C, $1,400,000,000.

MAPPING IS A LOCAL RESPONSIBILITY

A "map consciousness" has been carried to the White House and to Congress, but it has not yet become sufficiently important in the several states and communities to command the serious consideration of those who are in a position to inaugurate a comprehensive mapping program. Council's staff, Council's committee on surveys and maps program, the Division of Surveying and Mapping of the American Society of Civil Engineers, and many of those who recognize the fundamental need for accurate maps and appreciate the economic value of such basic data to the public, have done almost everything except lobby for substantial mapping appropriations. The people themselves must insist upon having maps for public works and private enterprise.

A number of federal government agencies other than the U. S. Coast and Geodetic Survey and the U. S. Geological Survey are making "special purpose" maps. Most of them are good maps, but they are not basic, and many cannot be fitted into a nation-wide basic mapping program. Engineers agree that if the triangulation and topography of the country were established on verified maps which were accurately related, it would not be necessary to make so many maps for special purposes. They also agree that the cost of making special maps, when they actually are needed, would be greatly reduced by having basic triangulation and topography as a foundation. In other words, it would be real economy to have this basic data for the guidance of all enterprise concerned with the earth's surface within the United States.

Washington, D.C.
July 1, 1937

Reprints of "Transactions" Papers to Be Available

IN THE NEXT few months, when work is progressing on the forthcoming publications of Volume 102 of TRANSACTIONS, authors, discussers, and other interested members should take special note of the conditions under which extra copies of papers from that volume are available.

Ordinarily, reprints are not made of papers in PROCEEDINGS. When the type is on the presses for the final printing of TRANSACTIONS, the Society places an order for 100 or more reprints of each paper, including 25 complimentary copies to the author and 2 or 3 to each discusser. At the present stage of the printing of Volume 102, any person who will need more than the complimentary allotment may place an advance order for quantities of 100 or more, the cost of which will be charged to him on the basis of actual bills from the printer, plus a handling charge.

The following schedule will serve as an approximate guide to those who may be planning to submit special advance orders:

APPROXIMATE MAXIMUM COSTS OF REPRINTS FROM VOL. 102 OF TRANSACTIONS

PAGES	EDITION				ADDITIONAL THOUSANDS
	100	200	500	1,000	
1 to 4	$13	$16	$24	$35	$16
5 to 8	15	18	26	39	21
9 to 16	17	21	31	48	28
17 to 32	21	22	39	62	41
Additional 32 pages	10	13	21	35	31

During subsequent years separate copies from the Society's stock at Headquarters are sold on request at prices ranging from 10 cents to $2.00 or more per reprint, according to the number of pages. These separates are termed reprints of TRANSACTIONS. Such reprints are published on the regular TRANSACTIONS paper, with covers of the same stock as that used for PROCEEDINGS. The Society has just published a price list of such papers reprinted from TRANSACTIONS since October 1930. The list supplements the previous "list of papers available" issued in June 1930, and copies of both lists may be secured without charge upon application to Headquarters. The papers are given in numerical order, with title, name of author, and price. Members are entitled to the usual 50 per cent discount on all papers listed. Special orders placed in advance, being based on actual costs, are not subject to this discount.

Members interested in obtaining a list of Society papers classified by subject or by author are referred to the cumulative indexes to TRANSACTIONS, published in 1921 and 1934, and to the annual indexes in the subsequent volumes.

Appointments of Society Representatives

F. R. LAYNG, W. H. PENFIELD, and LOUIS YAGER, Members Am. Soc. C.E., and F. S. HEWES, and J. DE N. MACOMB, Associate Members Am. Soc. C.E., have been appointed Society representatives on the Committee on Stresses in Railroad Track of the American Railroad Engineering Association.

ARTHUR W. DEAN, CHARLES M. SPOFFORD, and FRANK E. WINSOR, Members Am. Soc. C.E., served as Society representatives at the funeral of HARRISON P. EDDY, Past-President Am. Soc. C.E.

J. K. FINCH, M. Am. Soc. C.E., has been appointed to represent the Society on the Library Board of the Engineering Societies Library.

News of Local Sections

CLEVELAND SECTION

The members of the Cleveland Section were guests of the Case School of Applied Science Student Chapter at a joint dinner meeting held at the Case Club in Cleveland on May 26. Dr. W. E. Wickenden, president of the School, welcomed the guests, among whom were members of the Student Chapters at Akron University and Ohio Northern University. The feature of the occasion was the annual presentation of Section prizes to one outstanding senior in each of the three schools. The senior-class members of the Case School then gave brief résumés of their theses, followed by demonstrations in the various laboratories at the school. The June meeting of the Section took the form of a luncheon held in the Chamber of Commerce club rooms on the 23d. On this occasion William Stinchcomb, director of the Cleveland Metropolitan Park Board and recent recipient of the Cleveland Chamber of Commerce award for meritorious service, spoke. His comments on the purpose, accomplishments, and needs of the Park Board were very interesting.

DETROIT SECTION

There were 28 present at a meeting of the Detroit Section held at the Hotel Statler on June 11. A talk on "The Work of the Lake Survey" was given by Charles R. Pettis, colonel, Corps of Engineers, U. S. Army. Colonel Pettis discussed the recent investigations into the hydrologic studies of evaporation and the flow of underground water to and from the Great Lakes. An enthusiastic discussion followed his talk, and a pleasant social hour concluded the meeting.

PHILADELPHIA SECTION

The annual meeting of the Philadelphia Section took place at the Engineers' Club on June 16, with Charles H. Stevens serving as chairman. The guest of honor on this occasion was Lyle F. Bellinger, Vice-President from Zone II, who discussed the Society's tentative plan for allocating all members of the Society to some Section. Following Mr. Bellinger's remarks, the following speakers were heard on the technical program: C. P. Shantz, of the bridge engineering department of the Pennsylvania Railroad; H. A. Windish, of the Pennsylvania State Highway Department; and R. W. Baily, president of the Concrete Vibrator Equipment Company. It was then announced that the Section officers for the coming year will be as follows: William H. Chorlton, president; William E. A. Doherty and Scott B. Lilly, vice-presidents; Charles A. Howland, secretary-treasurer; and John C. H. Lee, Harry M. Freeburn, Lester L. Lessig, and Samuel I. Sacks, directors. At the conclusion of the meeting refreshments were served. There were 50 present, while 38 attended the dinner prior to the meeting.

PUERTO RICO SECTION

At a recent meeting held in San Juan, P.R., the Puerto Rico Section of the Society passed a resolution expressing the opinion that the water supply and sewage disposal systems "under consideration for the city of San Juan are both necessary and urgent as a protection against the hazards of disease and fire." Copies of this resolution were sent to a number of authorities, including the Secretary of the Interior, the governor of Puerto Rico, the city manager of San Juan, and the city engineer of San Juan.

SACRAMENTO SECTION

The Sacramento Section held its usual weekly luncheon meetings during the month of June. There were 43 present at the meeting held on June 1, at which two sound motion pictures—"Communications, News, and Views," and "Voices in the Air"—were shown. These were presented by B. E. Marsh, Sacramento manager of the Pacific Telephone and Telegraph Company, who prefaced the program with some interesting remarks on the development of world-wide communication. "From Mountain to Cement Sack" was the subject of a talk and motion picture given by Jay Jellick, district engineer of the Portland Cement Association, on June 8. There were 55 present. The attendance at the June 15th meeting numbered 53. On this occasion P. T. Robinson, engineer of maintenance of way and structures for the Southern Pacific Company, discussed the modern streamlined train. The 41 members and guests present at the meeting held on June 22 heard L. Deming Tilton, administrative officer of the State Planning Board and consultant for the National Resources Committee, speak on public works planning. The 700th meeting of the Section was celebrated on June 29 with an unusually large attendance—200 at the luncheon and 253 at the technical session following it. The program consisted of a new four-reel sound motion picture of the entire construction of Boulder Dam. The picture was shown through the courtesy of the U. S. Bureau of Reclamation. In connection with this presentation a talk was given by Walker R. Young, construction engineer during the building of the dam.

SAN DIEGO SECTION

On June 24 the members of the San Diego Section were guests of the California Water and Telephone Company at the company's new filtration plant near Nestor in the Tijuana Valley. Phil Rice and Clayton Meill, respectively manager and engineer of the company, acted as hosts. After a chicken dinner the visiting engineers were shown through the filtration plant. This plant purifies the water supply for the city of Coronado, Calif., which comes from the underground supply in the Tijuana Valley. There were 18 present at this meeting, which is the last until the fall.

SAN FRANCISCO SECTION

The San Francisco Section reports a number of interesting activities. On May 20 a joint meeting of the Section and local branches of the Founder Societies was held in the auditorium of the Pacific Gas and Electric Company, with 450 in attendance. The speakers were Charles Derleth, Jr., professor of civil engineering and dean of the college of engineering at the University of California, and Col. John H. Skeggs. On June 9 there was a luncheon at the Engineers' Club in honor of Louis C. Hill, President of the Society, and Harry W. Dennis, Vice-President. There were 68 present. An excursion to the Broadway Low Level Tunnel in Oakland was enjoyed by 87 members on June 12. A regular meeting of the San Francisco Section was held at the Engineers' Club on June 15, with 106 members and guests present. On this occasion a talk on the proper treatment of technical writing subjects was given by N. A. Bowers, Pacific Coast editor of the *Engineering News-Record*.

SYRACUSE SECTION

On May 27 the Syracuse Section was host to the senior-class members of the Syracuse University Student Chapter. The annual election of officers, held at this time, resulted as follows: Earl F. O'Brien, president; George A. Helmstetter, first vice-president; S. D. Sarason, second vice-president; Elmer K. Buell, director; and M. H. Sturtevant, secretary-treasurer. The principal speaker was S. C. Hollister, dean of the college of engineering at Cornell University. There were 21 present.

TENNESSEE VALLEY SECTION

There were 36 members and guests present at the May meeting of the Asheville Sub-Section of the Tennessee Valley Section, which was held at the George Vanderbilt Hotel. Talks were given by J. E. Goddard, chief of the engineering data section of the Tennessee Valley Authority, who described the mapping program of the Authority; and C. E. Waddell, consulting engineer of Asheville, who discussed the aims of the Society and of the Asheville Sub-Section. A committee consisting of Dr. Waddell, J. L. Lamson, and W. J. Parks, Jr., was appointed to report on the suitability of hydraulic symbols. There were 34 present.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for September

AMONG the articles scheduled for the September number of CIVIL ENGINEERING is one by the late John H. Gregory, former Director of the Society and professor of civil and sanitary engineering at the Johns Hopkins University, on water purification and public health. Read during the twenty-fifth anniversary celebration of the Johns Hopkins School of Engineering in February 1937, shortly after Professor Gregory's death, the paper reviews the broader aspects of accomplishments in water purification in this country since the beginning of the century. After describing developments in the physical, chemical, and bacteriological correction of water, the article gives data for and emphasizes the reduction of typhoid fever death rates which has taken place in various American cities since 1900, largely as a result of the extension and improvement of purification processes during that period.

In an article entitled "Buildings Have Pulses," Jacob J. Creskoff, consulting engineer, Philadelphia, Pa., describes modern methods for analyzing and reducing the vibrations of structures. Although every building vibrates to greater or lesser degree under the action of impressed forces, these vibrations are usually of such low amplitude and frequency that they are difficult to detect. However, when the period of the actuating force corresponds with the natural period of vibration of the building, the movements of the latter may become noticeable to occupants and even alarming. Such natural or dominant periods may be discovered by employing a sensitive vibrograph with or without the use of a shaking machine. When the building vibrates in more than one direction at the same time tridimensional vibrograph records will assist in analyzing its movements and tracing the source of the trouble so that remedial measures can be taken.

In launching a large project, the engineer is frequently called upon to outline a method for financing construction, so that the determination of bond maturities often becomes a vexing problem. But there are certain conditions under which the date of maturity may be arrived at mathematically, as pointed out by Allan T. Ricketts, M. Am. Soc. C.E., consulting engineer, Short Hills, N.J., in a third article scheduled for the September issue. Formulas and curves have been developed by the author for a number of these cases.

If space permits, there will be included an article on the proper anchorage of mill roofs to minimize wind-storm damage, prepared by H. A. Sweet and R. C. Corson, engineers of the Associated Factory Mutual Fire Insurance Companies of Boston, Mass. The destruction wrought by tornadoes and wind squalls can be greatly reduced at a very small cost simply by providing sufficient anchorage for the roofs of mills and other structures to resist the straightaway winds which blow from all directions towards the storm centers. Practical means for securing connections of ample strength are suggested in the paper, and a number of popular misconceptions regarding the action of high winds on buildings are dispelled.

Beautiful American Water Towers

ONCE AGAIN, in its series of pages of special interest devoted to "Art in Engineering," CIVIL ENGINEERING presents a picture of a water tower. The March issue depicted a recent Chinese structure, and the May issue an ancient Mexican one. This month's subject is American in conception, design, and location.

ELEVATED WATER TANK AT INDIAN HILL, CINCINNATI, OHIO

It is the Washburn Park Standpipe, at Minneapolis, Minn., a 1,500,000-gal tank constructed throughout of reinforced concrete. A fine regard for esthetics has made this purely utilitarian structure a thing of beauty, worthy of its surroundings. The city engineer was N. W. Elsberg, the supervisor of the water department J. A. Jenson, and the engineer in charge C. C. Wilbur.

A different architectural treatment of the same type of structure is illustrated by the 500,000-gal tank at Cincinnati, Ohio, shown in the accompanying picture. The architect was Charles Frederick Cellarius, and the chief engineer, John S. Raffety, Assoc. M. Am. Soc. C.E.

Both photographs were supplied through the courtesy of William S. Hewett, M. Am. Soc. C.E.

Wise and Otherwise

A RECENT incident in the adventurous life of Professor Abercrombie has been called to the attention of the editor by Harold C. Fiske, M. Am. Soc. C.E. It appears that the Professor suddenly became aware of certain unsettled conditions prevailing in the world at large. He quickly expressed these various problems, as he saw them, in equivalent mathematical terms, and with his usual skill reduced the whole question to the determination of two unequal quantities such that the square of the first should be equal to the second and the square of the second equal to the first. The character of these quantities, which may easily be determined by simple algebra, brought peace to the soul of the Professor for reasons which will probably become apparent upon solution of the problem.

Three problems were propounded by Professor Abercrombie in the July number of CIVIL ENGINEERING. The first asked how many days it would require a snail to climb out of a well 20 ft deep if he climbs up 5 ft each day and slips back 4 ft each night. A little consideration will indicate that the answer is 16 days.

In the second problem, two automobiles 90 miles apart are traveling toward each other, the first at the rate of 40 miles per hour and the second at the rate of 20 miles per hour. A fly leaves the front bumper of the faster car and flies to the front bumper of the other. The insect continues to shuttle back and forth until crushed between the bumpers as the cars come together. The fly's total mileage was asked, its rate of speed being given as 70 miles per hour. It is evident that the cars will come together at the end of $1\frac{1}{2}$ hours, during which time the fly will have travelled $1\frac{1}{2} \times 70$ or 105 miles.

The third problem involved the multiplication of amebas in a glass. Starting with seven, they double in number every 20 minutes. Given that the glass would be completely filled in 3 days, the question was asked, "How long will it be before the glass is half full?" Since the amebas double in number every 20 minutes, the glass will be exactly half-full in 2 days, 23 hours, 40 minutes.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

A Selected List of Books for Civil Engineering Students

FOR SEVERAL years the civil engineering department of the Newark College of Engineering has published lists of books from which junior and senior students are required to select their summer reading for credit. A minimum of five books is required for a passing grade and in general grades of "B" and "A" are given for seven and ten titles, respectively.

In contrast to the rather limited scope of reading available to engineers who abjure non-technical matter, these lists represent a wide variety of subjects, with emphasis in general on science, history, and biography. The books for the year 1936 are grouped in the following classes:

Group I:	Sanitary science and public health
Group II:	Novels, particularly novels with a background of engineering or adventure
Group III:	Biography
Group IV:	History and social science
Group V:	Stories of adventure
Group VI:	Scientific books
Group VII:	Civil engineering

Lack of space prevents inclusion of more than one of these classes here. Inquiries about the other six groups should be addressed to the Department of Civil Engineering, Newark College of Engineering, Newark, N.J.

GROUP VII. BOOKS DEALING WITH CIVIL ENGINEERING (1936 LIST)

AUTHOR	TITLE
Allhands	GRINGO BUILDERS
Adams	THE BUILDING OF THE CITY
Bathe	OLIVER EVANS
Bishop	GOETHALS, GENIUS OF THE PANAMA CANAL
Bond	ON THE BATTLEFRONT OF ENGINEERING
Clark	WILLIAM L. SIBERT
Crowther	THE RISE AND ROMANCE OF THE AMERICAN TROPICS
Dickinson	RICHARD TREVITHICK
Ellsburg	ON THE BOTTOM
Fleming and Brocklehurst	A HISTORY OF ENGINEERING
Freeman	R. E. LEE, Vol. I
Gibb	THE STORY OF TELFORD
Gibbon	STEEL OF EMPIRE
Gregory	THE STORY OF THE ROAD
Hammond	AUTOBIOGRAPHY OF JOHN HAYS HAMMOND
Harlow	OLD TOWPATHS
Henry	TRAINS
Holland	BIG BRIDGE
Holland	HISTORIC RAILROADS
Hodgins	BEHEMOTH, THE STORY OF POWER
Hungerford	THE STORY OF THE BALTIMORE AND OHIO RAILROAD
Kirby-Laurson	EARLY YEARS OF MODERN CIVIL ENGINEERING
Lenard	GREAT MEN OF SCIENCE
Merejkowski	THE ROMANCE OF LEONARDO DA VINCI
Nesbitt	DESOLATE MARCHES
Perkins	TRAILS, RAILS AND WAR; THE LIFE OF GENERAL G. M. DODGE
Prout	LIFE OF GEORGE WESTINGHOUSE
Pupin	FROM IMMIGRANT TO INVENTOR
Quiett	THEY BUILT THE WEST
Sedgwick and Tyler	A SHORT HISTORY OF SCIENCE
Schuyler	THE ROEBLINGS, A CENTURY OF PROGRESS AS BRIDGE BUILDERS AND INDUSTRIALISTS
Scientific American Publishing Company	PICK, SHOVEL AND PLUCK
Scientific American Publishing Company	WITH THE MEN WHO DO THINGS
Smiles	LIVES OF THE ENGINEERS
Starr	ONE HUNDRED YEARS OF AMERICAN RAILROADING
Starrett	SKYSCRAPERS AND THE MEN WHO BUILD THEM
Stevers	STEEL TRAILS
Swain	THE YOUNG MAN AND CIVIL ENGINEERING
Turnbull	JOHN STEVENS, AN AMERICAN RECORD
Vauclain	STEAMING UP! THE AUTOBIOGRAPHY OF SAMUEL M. VAUCLAIN
Vowles	THE QUEST FOR POWER, FROM PREHISTORIC TIMES TO THE PRESENT DAY
Wells	SIX YEARS IN THE MALAY JUNGLE
Wilson	GREAT MEN OF SCIENCE

Meetings at Twenty O'clock

THE SCHEME of numbering the hours of the day consecutively from 1 to 24 seems strangely foreign. Yet, curiously enough, it is of American origin, and when it was adopted in England in 1884 it was popularly known as the "American system." The Society itself, and one or two other scientific organizations in the United States, used it for some time, announcing meetings "at 20 o'clock."

Prior to 1883 the railroads operated on local time. Preparing a time table must have been something of an exercise in mathematics, for the clocks in cities no farther apart than Chicago, St. Paul, and St. Louis were all based on local meridians, differing from each other by minutes and seconds. By 1881 the confusion had become so great that the Society appointed a committee on uniform standard time, which set up a tentative system of hour meridians and circulated a questionnaire among railroad officials of the United States and Canada to determine their reaction. Largely as a result of that work, the railroads reached an agreement on hour meridians in October 1883, and put it into effect the following month. The numbering of hours from 1 to 24 was suggested at the same time, but was adopted only by the Canadian roads.

The next step was, obviously, to establish an international standard or base meridian, from which time could be figured by hourly intervals throughout the world. The Society's committee and other interested groups brought the attention of Congress to the need for such an arrangement, and as a result the President of the United States was authorized in 1884 to call an international conference to discuss the subject. Twenty-six nations were represented.

At that conference the Greenwich meridian was selected as the base. The "1 to 24" system of numbering hours was also approved, and was adopted by the Greenwich observatory (England) the following year. In the United States, the *Railroad Gazette* commented editorially: "The foremost observatory in the world has inaugurated a reformation in time-recording for the most conservative nation in the world, and we now feel much encouraged to believe that before long Americans will also accept and use the 'American system.'"

However, the United States never followed suit, despite the fact that a great number of railroad managers signified their approval. The Society continued to meet "at 20 o'clock" until October 3, 1899, when the Board decided to return to the 12-hour system. The Secretary's minutes for that day show that the session convened at 20: 30, and adjourned at 11:15 p. m. Today the "American system" is far better known abroad than at home.

John H. Gregory Library to City of Columbus

IN ACCORDANCE WITH a wish expressed shortly before his death, the professional library of the late John H. Gregory, M. Am. Soc. C.E., has been presented to the City of Columbus, Ohio. Ceremonies to mark the formal opening and dedication were held on May 7, 1937, in the Council Chamber of the City Hall.

The library comprises books, periodicals, plans, and documents on sanitary and municipal engineering, carefully selected by Mr. Gregory over a period of 42 years. It has long been recognized as one of the most valuable collections in these fields, not only because of its content, but because of the systematic and extensive filing system that makes its information so readily available.

It is especially fitting that the City of Columbus should be the recipient of this gift, as Mr. Gregory was actively identified with the design and construction of all the major water and sewerage works built by that municipality since 1904. At the time of his death he was consultant on the activated sludge sewage treatment works that are now nearing completion.

The collection, housed in Room 229 of the City Hall Building, has been designated the John H. Gregory Sanitary and Municipal Engineering Reference Library. By the terms of the gift, it is to be kept up to date—a provision which includes continuing the subscriptions to numerous engineering periodicals and professional society publications.

Bills Favored by Engineers Pass New York Legislature

IN THE RECENT session of the New York State Legislature, three bills sponsored or endorsed by the engineering profession were enacted into law. All the bills opposed by the engineering profession were

killed in the legislature with one exception, and that was vetoed by the governor.

The bills passed included one to require professional supervision of construction by either a registered engineer or architect, one to amend the Engineers' Law so as to restrict non-resident exemptions to legally qualified men, and one to amend the highway law so as to provide for construction of sidewalks and lighting adjacent to state highways and county roads. Among the eight bills that failed of enactment were one that would have restricted the engagement of consulting engineers and architects, and their assistants, on public work, and another that would have lowered the educational and experience requirements for a professional engineers' license.

Legislative representation at Albany on behalf of the engineering profession was headed by the late Arnold G. Chapman, M. Am. Soc. C.E., past-president of the New York State Society of Professional Engineers and chairman of its Committee on Legislation. Mr. Chapman died shortly after the close of the session.

Specifications for Street Paving Issued by American Public Works Association

TWENTY-TWO standard specifications in the field of street paving have recently been issued by the American Public Works Association, Chicago, Ill. These include nine dealing with pavement foundations, two with sidewalks and curbs, one with brick pavements, one with stone block pavements, and nine with bituminous pavements. The pages are $5^1/_2$ by $8^1/_2$ in., printed on one side only, and punched for a standard loose-leaf binder. The specifications for portland-cement concrete pavements and for sewer construction are now being revised and will be given publication in the same format in the near future.

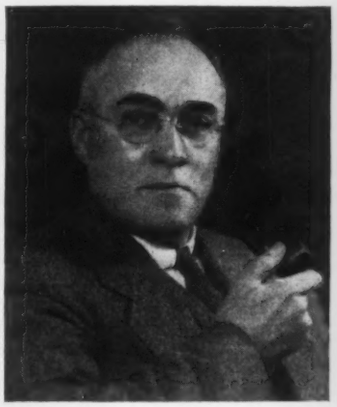
The present work constitutes a revision and assembling of the specifications published as of 1936 by the American Society of Municipal Engineers, now merged with the International Association of Public Works Officials to form the American Public Works Association. These specifications are intended to serve the public works engineer as guides or models for the preparation of actual contract specifications, and will enable him to be confident that no essential item is overlooked and that the materials and construction methods specified conform to good practice.

Cleveland Chamber of Commerce Awards Medals for Public Service

BEGINNING in 1924, the Cleveland Chamber of Commerce has made annual awards of medals for conspicuous public service. In all, 31 residents of the city, prominent in the fields of business, the professions, education, and public office, have been thus honored, the list including a number of well-known names. Robert Hoffmann, Hon. M. Am. Soc. C.E., has been a recipient of the medal.

This year one of the awards goes to another Member of the Society, William A. Stinchcomb, director and secretary of the Cleveland Metropolitan Park Board. The other two recipients are Dudley S. Blossom, chairman of the Community Fund, and the Rev. Dan F. Bradley.

The citation accompanying Mr. Stinchcomb's award reads as follows:



WILLIAM A. STINCHCOMB

"The Cleveland Medal for Public Service is bestowed upon William A. Stinchcomb as a living testimonial of the regard in which he is held by his fellow citizens for exemplifying to them the highest type of the career man in public service. Appointed assistant city engineer 36 years ago, he has employed his unusual professional talents almost continuously since in advancing the interests of this community. In particular he has made an enduring contribution to the public welfare in the upbuilding of the Metropolitan Park System, whose trustees he has served as director-secretary for 16 years. For this, posterity, as well as the present generation, will remember him gratefully."

Additional Honorary Degrees Awarded

SINCE the July issue of CIVIL ENGINEERING went to press, news of other members awarded honorary degrees during the past commencement season has been received at Society Headquarters. These are as follows:

FRANCIS C. MCMATH, M. Am. Soc. C.E., doctor of engineering, Wayne University (Detroit).

GIOVANNI RODIÓ, M. Am. Soc. C.E., doctor of engineering, University of Lausanne.

STEPHEN F. VOORHEES, M. Am. Soc. C.E., doctor of engineering, Princeton University.

CLEMENT C. WILLIAMS, M. Am. Soc. C.E., doctor of engineering, Bucknell University.

National Resources Committee Surveys Technological Trends

NEW INVENTIONS necessitate constant revision of national policies, according to the 388-page report of the subcommittee on technology of the National Resources Committee, on "Technological Trends and National Policy," made public on July 18, 1937.

This first report on the science resources of the United States deals with new inventions and their social implications and calls attention to the need for planning to meet the new situations caused by technological advance. It includes a survey of most of the great fields of technology and applied science, namely, agriculture, mining, transportation, communication, the construction industries, power production, the metallurgical and chemical industries, and the electrical manufactures.

The report recommends that a federal committee should be responsible for keeping abreast of technological changes and for forecasting imminent changes that may affect national life. This group should be composed of representatives of the Departments of Labor, Commerce, and Agriculture, the Bureau of Mines, the Interstate Commerce Commission, the Social Security Board, and WPA, with such cooperation from industry and research organizations as may be necessary to obtain complete information.

The National Resources Committee also urges that a series of continuous studies, independent of the joint committee of federal agencies, be undertaken by existing planning boards and by appropriate agencies developed by the federal government—and more specifically, that there be set up, in the various interested departments, science committees with the definite function of investigating and reporting on the progress and trends of science and invention and the possible social and economic effects which may follow them. It is further recommended that these agencies concentrate their initial efforts on inventions which promise to play an immediate part in future technological changes. Of interest to civil engineers is the specific inclusion in this list of air-conditioning equipment, plastics, the photoelectric cell, synthetic rubber, and prefabricated houses.

To explore the more technical aspects of the question it is suggested that the Science Committee of the National Resources Committee, with the cooperation of other scientists, make an investigation of the adequacy of reporting on inventions and discoveries in applied science and advise on the feasibility of more balanced coverage, of selecting those more socially significant, and of assembling such data in some central location.

The report was prepared by a large group of scientists and engineers identified with industrial, academic, and governmental activities. Among the contributors to the chapter on Construction Industries were O. H. Ammann, John C. Page, Malcolm Pirnie, Carlton S. Proctor, and H. W. Richardson, all members of the Society.

Texas Professional Engineers' License Law Passed

A PROFESSIONAL engineers' license law was passed at the last regular session of the Texas legislature and has been signed by the governor. This law requires that not later than January 1, 1938, any engineer having responsible charge of design or construction must be licensed in order to do business in Texas.

The basic requirement for licensing is graduation from an approved 4-year course in engineering followed by 4 years or more of active practice in engineering work, indicating that the applicant is competent to be placed in responsible charge of such work. Successfully passing an examination, together with 8 years of engineering practice, is a substitute requirement. In addition, within the first 5 years after the act becomes effective, applicants not less than 35 years of age who have practiced engineering work for 12 years or more, of which at least 5 have been in responsible charge, may be admitted. This latter clause applies only to those not practicing professional engineering at the time the act becomes effective.

The text of the professional engineers' license law was printed in full in the June issue of *The Texas Engineer*, official publication of the Texas Section.

Steel Construction Institute Announces Awards for Beautiful Bridges

AWARDS for the most beautiful steel bridges constructed during 1936 were announced by the American Institute of Steel Construction on June 29, 1937. First place in Class A went to the East River Crossing of the Triborough Bridge, New York, N.Y. In the same class, three other structures received honorable mention: The Henry Hudson Bridge, over the Harlem River, New York, N.Y.; the Fore River Bridge, between Quincy and Weymouth, Mass.; and the West Bay Crossing, San Francisco–Oakland Bay Bridge.

Of the Triborough Bridge Authority, O. H. Ammann is chief engineer; Allston Dana, engineer of design; Leon S. Moisseiff, consulting engineer; and Aymar Embury II, architect, all Members Am. Soc. C.E. On the Henry Hudson Bridge, the firm of Madigan and Hyland were the consulting and supervising engineers, and the firm of Robinson and Steinman, Members Am. Soc. C.E., were consulting engineers on design. Again, Aymar Embury II was the architect. The Fore River Bridge was designed and built by the Massachusetts Department of Public Works under George H. Delano, chief engineer, and George E. Harkness, M. Am. Soc. C.E., bridge engineer. The consulting architects were the firm of Desmond and Lord. The San Francisco–Oakland Bay Bridge was built by the Department of Public Works of the state of California, of which Charles H. Purcell, Assoc. M. Am. Soc. C.E., is chief engineer.

In Class B, first place was taken by the Hurricane Deck Bridge, across Sage Arm of Lake of the Ozarks, Camden County, Missouri; the firm of Sverdrup and Parcel, Members Am. Soc. C.E., were the engineers. The winner in Class C was the bridge carrying Astoria Boulevard over Grand Central Parkway Extension, in Queens County, N.Y. It was designed and built by the Long Island State Park Commission (Arthur E. Howland, M. Am. Soc. C.E., Chief Engineer) and the Triborough Bridge Authority.

These prizes have been awarded annually since 1928, to encourage attention to the aesthetic possibilities of steel bridges, and during that period, according to the Institute, "a sincere and growing interest in the architectural excellence of steel bridges has been noticeable." Selection of prize-winners is in the hands of a jury composed of leading consulting engineers and architects.

Brief Notes from Here and There

AT THE ANNUAL summer convention of the American Institute of Electrical Engineers, held in Milwaukee, Wis., on June 21–25, 1937, the officers for the year beginning August 1, 1937, were announced. Those newly elected are W. H. Harrison, New York, N.Y., for president; I. Melville Stein, Philadelphia, Pa., Edwin D. Wood, Louisville, Ky., L. N. McClellan, Denver, Colo., J. P. Jollyman, San Francisco, Calif., and M. J. McHenry, Toronto, Canada, for vice-presidents; C. R. Beardsley, Brooklyn, N.Y., V. Bush, Cambridge, Mass., and F. H. Lane, Chicago, Ill., for directors. For treasurer, W. I. Slichter, of New York, N.Y., was re-elected.

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OFFICERS for 1938, as announced by the Society for the Promotion of Engineering Education at its forty-fifth annual meeting, June 28–July 2, 1937, are as follows: For president, S. B. Earl, Clemson College, S.C.; for vice-presidents, Karl T. Compton, Massachusetts Institute of Technology, and S. C. Fulton, Texas Agricultural and Mining College. The offices of secretary and treasurer continue to be held by F. L. Bishop and W. O. Wiley, respectively.

* * * *

THE SOCIETY has been notified of the death of Dr. H. H. Jeffcott, secretary of the Institution of Civil Engineers, which occurred in London on June 29, 1937. Dr. Jeffcott served as secretary of this great organization for many years, filling his important executive post with distinction. Members of the Society who have had the pleasure of meeting Dr. Jeffcott and discussing with him English engineering practices and the procedures of the Institution will sincerely regret his death.

NEWS OF ENGINEERS

Personal Items About Society Members

R. L. SACKETT has resigned as dean of the engineering school at Pennsylvania State College after many years of service. Dean Sackett, who has been named dean emeritus of the college, will devote his time to the interests of the Engineers' Council for Professional Development, particularly the Committee on the Selection and Guidance of Engineering Students.

B. H. FRASCH, formerly division engineer in the Ohio State Department of Highways, has been appointed chief engineer of maintenance.

CHARLES T. DICKEMAN, lieutenant commander, Corps of Engineers, U. S. Navy, has left the naval operating base at San Diego, Calif., to serve as public works officer at the Marine Barracks, Quantico, Va.

D. L. ERICKSON, city engineer of Lincoln, Nebr., was recently appointed director of parks, public property, and improvements under a new form of government, which is a compromise between the mayor-council form and the city manager form.

FRED L. PLUMMER, consulting engineer and associate professor of structural engineering at the Case School of Applied Science, has been elected president of the Cleveland Engineering Society.

GEORGE N. CARTER is now with the Central Nebraska Public Power and Irrigation District at Ogallala, Nebr., where he is resident engineer on the construction of Keystone Dam.

AUGUST E. NIEDERHOFF, formerly in the U. S. Engineer Office at Mineral Wells, Tex., has entered the employ of the Aluminum Company of America at Pittsburgh, Pa. He is in the hydraulic engineering department.

C. W. EBUR, JR., is now senior draftsman with the U. S. Engineers at Pittsburgh, Pa. Previously he was a draftsman in the U. S. Department of Agriculture at Washington, D.C.

E. ARTHUR BELL has accepted the position of borough engineer of Essex Fells, N.J.

JEROME W. HOWE has been appointed dean of Worcester Polytechnic Institute and will assume his new duties in the fall. He was formerly professor and head of the department of civil engineering at the Institute.

JOHN C. BISSET has resigned as regional engineer for the WPA to become city engineer of Corpus Christi, Tex.

C. E. FORD, previously a sanitary engineer for George B. Gascoigne, of Cleveland, Ohio, has accepted a position as sales engineer for the National Carbon Company, Inc., of the same city.

OSCAR E. SELBY has retired as principal assistant engineer of the Big Four Railroad, ending an association of almost forty-eight years with that line.

WILLIAM D. Schoell is now employed as a draftsman for the Soo Line Railroad at St. Paul, Minn.

C. V. MAXWELL, JR., has resigned from the Tennessee Valley Authority to become connected with Gardner and Howe, structural engineers of Memphis, Tenn.

DUNCAN J. KERR has been named president of the Lehigh Valley Railroad Company, with headquarters in New York City. Mr. Kerr's extensive experience in

DUNCAN J. KERR

railroad work includes sixteen years with the Great Northern Railway. In June 1936 he became connected with the Lehigh Valley Railroad Company in the capacity of assistant to the president.

ROBERT M. LINGO has just completed a year of active duty in the U. S. Army at Fort Riley, Kans., and is beginning work as an operator in the new water plant at Boonville, Mo. He also has charge of the chemical and bacteriological laboratory connected with the plant.

WILSON T. BALLARD, formerly an engineer for the PWA in Baltimore, Md., has been appointed to a similar position with the Baltimore County Metropolitan District.

ANSON J. GERNER, for 16 years superintendent of irrigation and construction for the Fresno (Calif.), Irrigation District, has been appointed manager and chief engineer of the District.

FREDERICK A. ALLNER, previously vice-president of the Pennsylvania Water and Power Company, has been appointed a member of the Maryland State Board of Health.

PAUL J. HALLORAN, lieutenant commander, C.E.C., U. S. Navy, has been transferred from the Marine Barracks at Quantico, Va., to Tutuila, Samoa, where he will be public works officer.

CLARENCE O. SHERRILL, president of the American Federation and former city manager of Cincinnati, Ohio, has been appointed to serve again as city manager.

JOHN E. ROLLER, who has been employed in the inspection division of the PWA at Miami, Fla., is now resident engineer for the Georgia Highway Department at Mt. Vernon, Ga.

VICTOR W. ANCKAITIS has resigned as administrative assistant for Pennsylvania District 3 of the WPA to become an engineer for the Tilghman Moyer Company, architects, engineers, and contractors of Allentown, Pa.

ROLAND H. TAYLOR, formerly an engineer for the Columbia Construction Company at Bonneville, Ore., has become manager of the Industrial Equipment Company at Los Angeles, Calif.

JOHN G. MARR is now city plan engineer for the City Planning Commission of Oakland, Calif. He was formerly assistant engineer for the City Plan Commission of St. Louis, Mo.

PHILIP G. LANG, JR., engineer of bridges for the Baltimore and Ohio Railroad, has been elected president of the Engineers' Club of Baltimore.

JAMES A. ERSKINE has left the Indiana State Highway Commission, where he was a project engineer on bridge construction, to engage in line relocation in Iowa for the Rock Island Railroad.

RALPH B. PECK is now a detailer for the American Bridge Company at Ambridge, Pa.

WILLIAM M. ROBINSON, JR., formerly civil and valuation engineer, of Augusta, Ga., has become chief engineer of state parks in the Department of Natural Resources of Georgia. His headquarters are in Atlanta, Ga.

FREDERICK E. TURNEAURE, dean of the college of mechanics and engineering, University of Wisconsin, has been awarded the tenth Lamme Medal of the Society for the Promotion of Engineering Education. This award, which is given for achievement in engineering education, was

FREDERICK E. TURNEAURE

made at the forty-fifth annual meeting of the society, held at the Massachusetts Institute of Technology and Harvard University, June 28–July 2, 1937. Dean Turneaure was elected an Honorary Member of the American Society of Civil Engineers in 1933.

IRA GRANT HEDRICK, JR., formerly draftsman for H. R. Carter, of Little Rock, Ark., has taken a position as d tailer for G. E. Beggs, of Princeton, N.J.

HARRY BIRNBAUM has resigned as junior civil engineer in the U. S. Forest Service at Winchester, Ky., to become connected with the U. S. Engineers Rock Island District Land Section, with headquarters at Hannibal, Mo.

FRANK T. SHEETS was recently elected president of the Portland Cement Association. He will assume his new duties on September 1. Since 1934 he has been consulting engineer and director of develop-

FRANK T. SHEETS

ment of the Association, and prior to that time he was associated with the Illinois State Highway Department for 23 years. He has served as president of the American Association of State Highway Officials and of the Central Illinois Section of the Society.

JOHN H. WILSON, previously with the Lowe Machinery Company, of Chicago, Ill., is now in the employ of the Walsh Construction Company, Oneonta, Ala.

A. A. JAKKULA has left the University of Michigan, where he was assistant professor of civil engineering, to accept a position as associate professor of civil engineering at the Agricultural and Mechanical College of Texas.

LEE D. MORK is now an assistant engineer for the Minnesota and Ontario Paper Company, International Falls, Minn. Formerly he was an instructor in the civil engineering department at Washington University, St. Louis, Mo.

ARCHIE N. CARTER recently entered the employ of the Firestone Plantations Company, of Akron, Ohio, in the capacity of junior planter. He will be stationed at Monrovia, Liberia, West Africa.

W. H. ROTH, formerly junior assistant draftsman for the Kansas State Highway Commission, is now a draftsman for the Burns and McDonnell Engineering Company, in Kansas City, Mo.

LAWRENCE WATERBURY, civil engineer of New York City, has joined the staff of Elwyn E. Seelye and Company, consulting engineers of the same city.

ELDON R. DODGE, formerly an instructor in civil engineering at the Case School of Applied Science, has taken a position in the department of hydraulics at the University of Wisconsin.

DECEASED

ROBERT ADAM (M. '00) consulting engineer, St. Leonards-on-sea, England, died on April 15, 1937, at the age of 72. Mr. Adam's long career included experience as resident engineer on the construction of the Blane Valley section of a new aqueduct for the Glasgow Corporation; as chief engineer to the contractors on the Stobcross section of the Glasgow Central Railway and the Yorkhill section of the Lanarkshire and Dunbartonshire Railway (the latter including the construction of underground stations); and as chief engineer on Vera Cruz (Mexico) Harbor work. Almost twenty years ago Mr. Adam established his consulting practice at St. Leonards-on-sea.

RUSSELL AVERILL ANDERSON (Assoc. M. '26) since 1935 director of finance, Michigan State Highway Department, Lansing, Mich., died on May 31, 1937, at the age of 40. Mr. Anderson was born in Wilmington, N.C., and graduated from the University of Michigan in 1922. Prior to his graduation, he was, successively, in the employ of the Michigan Northern Power Company; Hoad and Decker, consulting civil engineers of Ann Arbor, Mich.; and the J. G. White Management Corporation. From 1922 to 1925 he was assistant engineer for Hoad, Decker, Shoecraft, and Drury, and from 1925 to 1935 he was with the R. D. Baker Company, of Detroit—first as construction superintendent and engineer and, later, as vice-president and secretary.

CHARLES BROSSMAN (M. '18) consulting engineer of Indianapolis, Ind., and president of the Indiana Section of the Society, died suddenly on June 30, 1937. Mr. Brossman was born in Philadelphia, Pa., on January 17, 1877, and educated at the Philadelphia Manual Training School. He was with the Baldwin Locomotive Works from 1898 to 1899, except for a period of service in the Spanish-American War, and from 1900 to 1903 was engaged in design and construction work for the Indianapolis Water Company and for Dean and Shibley, of Washington, D.C. In 1904 Mr. Brossman established his consulting practice in Indianapolis.

NORMAN FREED BROWN (M. '09) consulting engineer of Pittsburgh, Pa., died on April 11, 1937. Mr. Brown was born at Coudersport, Pa., on March 20, 1878, and graduated from the University of Pennsylvania. In 1901 he joined the staff of the Pennsylvania Railroad Company, where he remained until 1918, being promoted from the position of rodman to that of assistant chief engineer. For the next two years he served with the American engineers in France, on location, design, and transportation work. From 1921 to 1922 Mr. Brown was director of public works for the city of Pittsburgh; from 1922 to 1923, vice-president of the Dravo Contracting Company; and from 1924 to 1932, director of public works for Allegheny County. In the latter year he established a private engineering practice.

CHARLES HOPKINS BYERS (M. '12) valuation engineer for the Western Pacific Railroad Company, San Francisco, Calif., died in Los Angeles, Calif., on May 7, 1937. Mr. Byers, who was 75, was born in Oskaloosa, Iowa, and educated at Oskaloosa College. His long engineering career included experience as a topographer for the Burlington and Western Railroad; as division engineer on construction for the Missouri Pacific Railway; as district engineer and assistant engineer for the Chicago, Milwaukee, and Puget Sound Railway Company; and as assistant district engineer and district engineer for the Interstate Commerce Commission, San Francisco. For a number of years before his death he was valuation engineer for the Western Pacific Railroad Company.

ARNOLD GOODWIN CHAPMAN (M. '20) consulting engineer of Albany, N.Y., died in New York City on June 3, 1937. Mr. Chapman was born in Guilderland, N.Y., on July 23, 1884, and graduated from Union College in 1906. From 1912 to 1915 he was deputy state engineer and surveyor (New York State), Barge Canal construction; from 1915 to 1923, in private consulting practice; from 1923 to 1924, deputy state engineer, Barge Canal and flood abatement; from 1924 to 1928, supervising engineer for New York State; and from 1928 to 1936, chief engineer, Albany Port District Commission, on the development of Albany as a sea port. About a year ago he entered private practice.

ROSCOE NATHANIEL CLARK (M. '07) city engineer of Hartford, Conn., and manager of the Bureau of Public Works of the Metropolitan District (of Hartford County), died in Hartford on June 6, 1937. He was 66. After graduating from Worcester Polytechnic Institute in 1892, Mr. Clark was employed for several years by various engineering firms. From 1896 to 1898 he was a topographical engineer on park surveys for the city of Hartford; from 1898 to 1901, an engineer for the Hartford Board of Park Commissioners; from 1902 to 1907, assistant engineer in the city engineer's office; and from 1907 to 1910, assistant city engineer. He became city engineer in 1911, and manager of the Bureau of Public Works in 1930.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

MELVILLE FISK CLEMENTS (M. '14) who was connected with the Northern Pacific Railway for the past thirty years, died at his home in St. Paul, Minn., on June 8, 1937. He was 62. Mr. Clements was born in What Cheer, Iowa, and educated at the University of Iowa. Following his graduation in 1899, he was employed by the Burlington, Cedar Rapids and Northern Railroad, and by the Chicago, Rock Island and Pacific Railway. In 1907 Mr. Clements took the position of assistant engineer with the Northern Pacific Railway, becoming bridge engineer in 1916. He was also consulting engineer on a number of outside projects, including the Suisun Bay Bridge near San Francisco and the Huey P. Long Memorial Bridge at New Orleans.

HUGH LINCOLN COOPER (M. '05) president of Hugh L. Cooper and Company, Inc., New York City, died at his home in Stamford, Conn., on June 24, 1937. Colonel Cooper, who was 72, was born in Sheldon, Minn. From 1884 to 1891 he was chief engineer and superintendent of the Chicago Bridge and Ironworks. After ten years of varied engineering experience, he then established a private consulting practice. During the war he served with the A. E. F. as colonel, Corps of Engineers, and he was chief engineer at Bordeaux during the period of maximum military port construction. He was recalled from France to direct the design and construction of the Muscle Shoals hydroelectric development on the Tennessee River. And from the completion of this project, in 1925, until 1932 he served as consulting engineer to the Soviet Government on the design and construction of the Dnieprostroy hydroelectric and navigation project.

HUGH L. COOPER

HARRISON PRESCOTT EDDY (M. '07) consulting engineer of Boston, Mass., died on June 15, 1937, in Montreal, Canada, where he had gone to receive honorary membership in the Engineering Institute of Canada. Mr. Eddy was born in Millbury, Mass., on April 29, 1870, and was educated at Worcester Polytechnic Institute. From 1891 to 1892 he was superintendent of the Worcester Sewage

Treatment Plant, and from 1892 to 1907 superintendent in charge of the Worcester Sewer Department. In the latter year Mr. Eddy established the engineering firm, Metcalf and Eddy, in Boston. He served as director of the Society from 1928 to 1930, and as President in 1934. (A longer account of Mr. Eddy's career appeared on page 528 of the July issue of CIVIL ENGINEERING.)

SIFROY JOSEPH FORTIN (M. '04) member of the Town Planning Commission of Montreal, Canada, died on May 16, 1937. Mr. Fortin was born at St. Sébastien, Canada, in 1867, and graduated from the École Polytechnique of Montreal in 1889. He held engineering positions with the American Bridge Works, of Chicago, and with Charles O. Brown, consulting engineer and contractor of Brooklyn, N.Y., and represented Milliken Brothers in Mexico City. Later he returned to Montreal, where he was, successively, deputy director of public works, chairman of the technical commission of the city, consulting engineer to the executive committee, and—from 1935 on—member of the Town Planning Commission.

FOSTER WARREN HARVEY (Assoc. M. '31) structural designer for the Missouri State Highway Department, died at his home in Jefferson City, Mo., on June 11, 1937. He was 37. Mr. Harvey was born in Jefferson City and graduated from the University of South Dakota in 1923. From 1923 to 1925 he was with the Illinois State Highway Department as instrumentman, inspector, and resident engineer, and from 1925 to 1928 he was a designer for Harrington, Howard and Ash, consulting engineers of Kansas City, Mo. In 1928 he became connected with the Missouri State Highway Department.

FREDERICK COLLAMORE HITCHCOCK (M. '05) president of Hitchcock and Tinkler, of New York City, died there on June 28, 1937. Mr. Hitchcock, who was 72, was born in Toledo, Ohio. From 1893 to 1905, he was general manager and partner in the contracting firm of George S. Good and Company; from 1906 to 1907, vice-president and general manager of the Construction Company of South America; from 1908 to 1916, vice-president and general manager of the MacArthur Brothers Company; from 1916 to 1918, vice-president and general manager of the Siems-Carey Railway and Canal Company, in China; and from 1919 to 1927, president of Carey, Campbell and Company, and vice-president of the W. F. Carey Company. In 1923 he formed the firm of Hitchcock and Tinkler, which built the Moffat Tunnel under the Continental Divide, one of the longest railroad tunnels in the Western Hemisphere.

WINFRED MILLER KALLASCH (M. '19) vice-president of the Illinois Hydraulic Stone and Construction Company, Elgin, Ill., died on June 8, 1937. Mr. Kallasch was born in Perry, Ill., and educated at the University of Nebraska. His early engineering career included experience as assistant and resident engineer for the Illinois Central Railroad, and as resident engineer for the Missouri Pacific Railroad. From 1917 to 1919 he was manager and general superintendent for the Leonard Construction Company, of Chicago, and from 1919 to 1924 general field superintendent for this organization. In 1925 Mr. Kallasch became vice-president and engineer for the Illinois Hydraulic Stone and Construction Company.

FRANK PERRY LARMON (M. '16) chief engineer of the Illinois Water Service Company, Champaign, Ill., died on June 3, 1937. Mr. Larmon was born in Salem, N.Y., on March 2, 1878, and graduated from Rensselaer Polytechnic Institute in 1900. His engineering career included experience as chief engineer and superintendent of the Consolidated Water Company, Utica, N.Y.; resident engineer on construction work in Cienfuegoes, Cuba; and chief engineer and acting manager of the Metropolitan Utilities District, Omaha, Nebr. In 1927 he entered the engineering department of the Federal Water Service Corporation, and later became chief engineer of the Illinois Water Service Company, a division of the former.

DANIEL EDWARD MORAN (M. '96) consulting engineer of New York City, died on July 2, 1937, at the age of 73. Mr. Moran was born in Orange, N.J., and graduated from Columbia University in 1884. He had an independent consulting practice until 1917, when the firm of Moran, Maurice and Proctor was formed. The title was later changed to Moran, Proctor and Freeman. Mr. Moran served as a consultant on the construction of

DANIEL E. MORAN

many New York skyscrapers and some of the largest bridges in the world, advising particularly on foundation problems. Among the structures on which he was engaged were the Mid-Hudson Bridge, the Philadelphia–Camden Bridge, the George Washington Bridge, and the Triborough Bridge. His invention of a concrete and steel "island" made the construction of the San Francisco–Oakland Bay Bridge possible.

CARROLL PAUL (M. '23) trustee of the Longyear estate and vice-president of the Longyear corporations, died at his home in Marquette, Mich., on May 23, 1937. Mr. Paul, who was 55, was born in Tokyo, Japan, and graduated from Dartmouth University in 1903. From 1904 to 1907 he was engineering aid and assistant engineer in the U. S. Navy, serving at various naval stations in the United States, the Philippines, and Guam. In 1922 Mr. Paul retired from the navy to take up work in Marquette in connection with the Longyear estate.

ARTHUR LOWRIE REEDER (M. '27) consulting engineer of Philadelphia, Pa., died suddenly at Gloversville, N.Y., on May 24, 1937. He was 57. Mr. Reeder was born in Camden, N.J., and graduated from the University of Pennsylvania in 1900. His varied experience included engineering positions with the Philadelphia (Pa.) Bureau of Filtration; the Water Department of Baltimore, Md.; the Pennsylvania Department of Health; the Reading (Pa.) Bureau of Water; and the Mahoning Valley Sanitary District. During these years he was concerned with the design, construction, or repair of 17 water purification plants and the design of several small sewage treatment plants.

CHRISTOPHER HENRY SNYDER (M. '01) designing and consulting structural engineer of San Francisco, Calif., died in that city on May 27, 1937, at the age of 71. Mr. Snyder was born in Fulton, Ill., and educated at the University of Illinois. He was a draftsman for the Keystone Bridge Company from 1890 to 1893, and from the latter year until 1912 he held a similar position with Milliken Brothers, of New York City. From 1912 until his death he was in private practice in California.

AMBROSE SWASEY (Hon. M. '21) Chairman of Board, the Warner and Swasey Company, Cleveland, Ohio, died at his summer home in Exeter, N.H., on June 15, 1937. Mr. Swasey was born at Exeter and educated in the public schools there. From 1869 to 1880 he was with the Pratt and Whitney Company, of Hartford, Conn. In the latter year he established a partnership, the Warner and Swasey Company, of Cleveland, which became world-famous for the manufacture of precision machines and instruments. Mr. Swasey instituted and endowed the Engineering Foundation. (A more extensive account of Mr. Swasey's career appeared on page 525 of the July issue of CIVIL ENGINEERING.)

JAMES WALLACE TOWER (M. '11) consulting engineer and partner in the firm of H. S. Ferguson, died at his home in New York City on June 21, 1937. Mr. Tower, who was 66, was born in Holyoke, Mass. From 1892 to 1899 he was draftsman and assistant engineer for E. A. Ellsworth, of Holyoke, Mass., and from 1899 to 1911 he was principal assistant engineer for the Great Northern Paper Company, of Millintocket, Me. During the latter period he also served as assistant engineer for H. S. Ferguson in the design and construction of paper mills at Millintocket. In 1911 Mr. Tower took the position of engineer in the New York office of H. S. Ferguson, and in 1929 he became a member of the firm.

ALLAN SHELDON WOODLE, JR. (M. '18) engineer of plant for the Baldwin Locomotive Works, Philadelphia, Pa., died on March 20, 1937. Mr. Woodle, who was 58, was born at Altoona, Pa. Following his graduation from Trinity College in 1899, he became connected with the Pennsylvania Railroad, where he remained until 1903. From 1903 to 1906 he was with the Baltimore and Ohio Railroad as assistant engineer on maintenance of way and as division engineer, and from 1906 to 1916 he was engineer in charge of construction and assistant plant engineer for the Baldwin Locomotive Works. After a year with the Eddystone Ammunition Corporation, he then returned to the Baldwin Locomotive Works.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From June 10 to July 9, 1937, Inclusive

ADDITIONS TO MEMBERSHIP

AKSOY, IBRAHIM SABIT (Jun. '36), 15 A Tepe Sokak, Cinarlar, Giresun, Turkey.

ALLIS, JOHN ARTHUR (Assoc. M. '36), Asst. Engr., U. S. Geological Survey (Res., 502 Ramsey St.), Stillwater, Okla.

ANDERSON, JOHN (Assoc. M. '37), Prof., Civ. Eng., The Citadel, Charleston, S.C.

BERGMAN, VICTOR ROBINSON (Jun. '37), Estimator and Engr., Godwin Constr. Co. (Res., 801 West End Ave.), New York, N.Y.

CAHILL, JOHN EDWARD (Jun. '37), With F. W. Kellberg, 320 Market St. (Res., 3 Fifth Ave.), San Francisco, Calif.

CHRISTENSEN, CHARLES CHAPIN (M. '37), Associate Structural Engr., Treasury Dept., Procurement Div., Public Buildings Branch (Res., 2145 C St., N.W.), Washington, D.C.

COLE, KENERLY OREAR (Assoc. M. '37), Promotion Engr., Portland Cement Assoc., Chicago, Ill.

COLGLAZIER, ROBERT WESLEY, Jr. (Assoc. M. '37), Asst. Director, Texas Dist. 10, WPA, 202 Chichester St., San Antonio, Tex.

COOK, JAMES RICHARD (Assoc. M. '37), Engr., Chester M. Everett, Box 555, Chappaqua, N.Y.

DIBRKING, GEORGE THOMAS (Assoc. M. '37), Res. Engr. Insp., PWA, Memphis, Mo.

ELFENDAHL, WILLIAM PRESTON (Jun. '36), Draftsman, Boeing Airplane Co. (Res., 2524 East Marion St.), Seattle, Wash.

GANNON, DONALD ARTHUR (Jun. '37), Asst. Engr., U. S. SCS, California 10, Upland, Calif.

GATES, ALBERT JAMES (Assoc. M. '37), Res. Engr., Joe E. Ward, 545 Harvey-Snider Bldg., Wichita Falls, Tex.

GIBSEN, FRANCIS EDWARD (Assoc. M. '37), Res. Engr., Roy B. Inks Dam, Buchanan Dam, Tex.

GREEN, WHARTON (M. '37), Liaison Engr., New York Worlds Fair 1939 Inc., Empire State Bldg., New York, N.Y.

GRIGGS, CHANDLER BABBITT (Jun. '37), 168 Clinton St., Brooklyn, N.Y.

GROVES, JOHN MEYBIN (Jun. '37), Junior Hydr. Engr., TVA, Box 352, Norris, Tenn.

HEDRICK, IRA GRANT, Jr. (Jun. '36), Detailer, G. E. Beggs (Res., 138 Fitz-Randolph Rd.), Princeton, N.J.

HERMANN, ARNE KURT PETER (Jun. '36), With U. S. Engrs., U. S. Marine Hospital, New Orleans, La.

JENKINS, HERBERT THEODORE (Assoc. M. '37), Asst. Prof., Civ. Eng., School of Civ. Eng., Cornell Univ. (Res., 921 East State St.), Ithaca, N.Y.

KELLOGG, MARKOE ORCUTT (Jun. '37), Draftsman, Sun Oil Co., 175 Newbury St., Boston, Mass.

LEAHY, PHILIP COUSENS (Jun. '36), Engr., WPA, Binghamton (Res., Whitney Point), N.Y.

LOVAN, CHARLES FELIX (Assoc. M. '37), Engr. and Contr. (Hillyer & Lovan), Box 371, Jacksonville, Fla.

MACMILLAN, WILLIAM WILSON (Jun. '37), Insp., Met. Water Dist., 111 North Vermont Ave., Glendora, Calif.

MCKINSTRY, ROBERT STANLEY (Jun. '37), Engr., Boeing Airplane Co. (Res., 4622 East 40th St.), Seattle, Wash.

MALLEY, FRANK HAROLD (Assoc. M. '37), Acting Secy., City Planning Board, Room 30, City Hall, Boston, Mass.

MANN, WARREN STATEN (Assoc. M. '37), Chf. Engr., The Dixie Culvert & Metal Co., 524 Forsyth Bldg., Atlanta, Ga.

MASON, MARTIN ALEXANDER (Jun. '37), Scientific Aid and Junior Mech. Engr., National Bureau of Standards (Res., 2902 Porter St., N.W.), Washington, D.C.

NEUMANN, BOHUSLAV (Assoc. M. '37), With Hydr. Dept., Phoenix Eng. Corporation, 2 Rector St. (Res., 500 West 110th St., Apartment 5-C), New York, N.Y.

NEWBERRY, RAGAN MCGREGOR (Jun. '36), With City of Neodesha, WPA Project (Res., 208 North 4th St.), Neodesha, Kans.

O'SHEA, THOMAS JOSEPH (Jun. '36), 1047 Ogden Ave., New York, N.Y.

OSTRANDER, HOWARD WILLIAM (Jun. '37), Camp Pine Grove P-209, Jackson, Calif.

PATCH, MARSHALL ARTHUR (Jun. '37), Junior Hydr. Engr., U. S. Geological Survey, Box 1311, Tucson, Ariz.

PETERSON, VICTOR JOEL (Assoc. M. '37), Asst. Res. Engr. Insp., PWA, Inspection Div., 1250 National Bank Bldg., Detroit, Mich.

PIEPOLI, NICHOLAS FRANCIS (Jun. '36), 1933 Tomlinson Ave., New York, N.Y.

PURINGTON, DONALD VARNEY (Assoc. M. '37), Asst. Engr., Bridge Div., State Highway Dept. (Res., 3709 Tom Green St.), Austin, Tex.

REED, EDWIN WILLIAM (Jun. '37), 94-33 Park Lane South, Woodhaven, N.Y.

REMING, CHARLES PETER (Assoc. M. '37), Valuation Engr., Gas Utilities Div., Railroad Comm. of Texas (Res., 4404 Speedway), Austin, Tex.

REYNOLDS, FRANCIS MARION (Assoc. M. '37), Asst. Engr., Survey and Plans, State Div. of Highways, Box 1499, Sacramento, Calif.

RICE, BORDEN PRATHER (Assoc. M. '37), San. Engr., State Board of Health, Columbia, S.C.

ROCK, ELMER (Jun. '37), Junior Engr., U. S. Engrs. (Res., 1563 Narragansett Boulevard, Edgewood), Providence, R.I.

ROGERS, CLARENCE FULLER (Assoc. M. '37), Associate Highway Engr., Div. of Management, Bureau of Public Roads, Washington, D.C.

ROUNTREE, SEABORN REUBEN, JR. (Jun. '37), 4901 Ave. G, Austin, Tex.

SANFORD, GEORGE OTIS (M. '37), Gen. Supervisor, Operation and Maintenance, Bureau of Reclamation, Washington, D.C. (Res., 3121 Fourth St., North, Arlington, Va.)

SCOVILLE, JOHN ALLEN (M. '37), Lt.-Commander, C.E.C., U.S.N., Navy Yard, Philadelphia, Pa.

SLEZAK, EDWARD JOHN (Jun. '37), Calculator, Mech. Design Dept., M. W. Kellogg Co. (Res., 1387 Jesup Ave.), New York, N.Y.

STRATTON, JAMES HOBSON (Assoc. M. '37), Capt., Corps of Engrs., U.S.A., U. S. Engr. Office, Custom House, Boston, Mass.

TONG, GEORGE HONG (Jun. '37), 524 North Los Angeles St., Los Angeles, Calif.

TSCHEBOTAREFF, GREGORY PORPHYRIEWITCH (M. '37), Asst. Prof., Civ. Eng., School of Eng., Princeton Univ., Princeton, N.J.

WHITE, FRANK EDWARD (Assoc. M. '37), Civ. Engr., PWA, New York (Res., 1722 Seventy Third St., Brooklyn), N.Y.

ZAMPELLA, ALBERT ANDREW (Jun. '37), Chf. of Party, New Jersey Riparian Survey, 236 Seventeenth Ave., Paterson, N.J.

TOTAL MEMBERSHIP AS OF JULY 9, 1937

Members	5,672
Associate Members	6,142
Corporate Members	11,814
Honorary Members	23
Juniors	3,514
Affiliates	87
Fellows	1
Total	15,439

MEMBERSHIP TRANSFERS

ALLEN, HAROLD (Assoc. M. '24; M. '37), Materials Engr., Div. of Tests, Bureau of Public Roads, 1901 Kenyon St., Washington, D.C.

BURCHARD, EDWIN DAY (Assoc. M. '25; M. '37), Dist. Engr., Water Resources Branch, U. S. Geological Survey, 220 Post Office Bldg., Asheville, N.C.

CHANG, HAN YING (Assoc. M.'34; M. '37), Vice-Director, Bureau of Hydr. Eng., National Economic Council, Nanking, China.

FRAGIN, LAWRENCE BAKER (Jun. '24; Assoc. M. '32; M. '37), Senior Engr., U. S. Engr. Dept., 816 U. S. Court House and Custom House, St. Louis, Mo.

HOSTRUP, CHRISTIAN FREDRICK (Assoc. M. '30; M. '37), Pacific Coast Mgr., The Pitometer Co., 504 Subway Terminal Bldg., Los Angeles (Res., 1213 Pacific St., Santa Monica), Calif.

IRVINE, JAMES OSBORNE (Jun. '33; Assoc. M. '37), Project Supt., U. S. Dept. of Agriculture, New Jersey Dept. of Conservation and Development, Butler (Res., 329 Park Ave., East Orange), N.J.

LALONDE, WILLIAM SALEM, JR. (Jun. '25; Assoc. M. '29; M. '37), Associate Prof., Civ. Eng., Newark Coll. of Eng., Newark, N.J.

MANNING, JOHN JOSEPH (Assoc. M. '22; M. '37), Commander, C.E.C., U.S.N., Bureau of Yards and Docks, Navy Dept., Washington, D.C.

MARCROFT, JOHN CLIFFORD (Jun. '28; Assoc. M. '37), Associate Civ. Engr., Chf. Eng. Div., U. S. Engr. Office, 214 Federal Bldg., Honolulu, Hawaii.

MUESER, WILLIAM HENRY (Assoc. M. '29; M. '37), Cons. Engr. (Moran, Proctor & Freeman), 420 Lexington Ave., Suite 1420, New York, N.Y.

PREECE, EDMUND FRANCIS (Assoc. M. '32; M. '37), Asst. Chf. Engr., National Park Service, Washington, D.C. (Res., 8315 Sixteenth St., Silver Springs, Md.)

SHADRAKE, BOLICK JOHN (Jun. '27; Assoc. M. '37), Draftsman, Office of Engr. of Structures, Erie R.R., 738 Midland Bldg. (Res., 3238 West 115th St.), Cleveland, Ohio.

STAMAN, LILBURN PIERCE (Jun. '28; Assoc. M. '37), Engr. in Chg., Flood Control Project, for City Engr., City Hall (Res., 3201 East 2d St.), Sioux City, Iowa.

TROY, ANTHONY VINCENT (Jun. '28; Assoc. M. '37), Asst. Engr., PWA, Inspection Div., 2 Lafayette St., New York (Res., 502 Van Cortlandt Park Ave., Yonkers), N.Y.

WAHLER, JOSEPH AUGUST (Assoc. M. '27; M. '37), Gen. Supt. of Constr., San Clemente Island, Care, 11th Naval Dist., San Diego (Res., 243 F. St., Chula Vista), Calif.

WINGO, JAMES FRANCIS (Jun. '29; Assoc. M. '37), Prin. Eng. Draftsman, International Boundary Comm., Am. Section (Res., 1101 East Rio Grande St.), El Paso, Tex.

WOOD, HAROLD AARON (Jun. '32; Assoc. M, '37), Junior Engr., United Pueblos Agency. Irrig. Div. Room 316, Federal Bldg., Albuquerque, N.Mex.

REINSTATEMENTS

GELLERT, NATHAN HENRY, Assoc. M., reinstated June 17, 1937.

GURLEY, LEON RAYMOND, Assoc. M., reinstated June 28, 1937.

HORTON, FREEMAN HUDSON, M. reinstated June 9, 1937.

RESIGNATIONS

GRILL, WILLIAM HENRY, Jun., resigned June 21, 1937.

HAUBER, FERDINAND RICHARD, Jun., resigned June 30, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

August 1, 1937 NUMBER 8

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

ADAMS, FREDERICK CARL, JR., Brooklyn, N.Y. (Age 23.) Refers to R. C. Brumfield, F. E. Foss.

ALEN, RUPERT OLE, Eureka, Calif. (Age 22.) Refers to C. Derleth, Jr., C. T. Wiskocil.

ALLEN, JOHN WILLIAM, Akron, Ohio. (Age 29.) Refers to F. E. Ayer, J. W. Bulger, R. C. Durst.

ANDERS, ROLAND URANN, Ozone Park, N.Y. (Age 21.) Refers to R. C. Brumfield, F. E. Foss.

ANDERSON, EDWARD WALTER, New York City. (Age 22.) Refers to W. Allan, R. E. Goodwin.

ANDERSON, JOHN DAVID, Indianapolis, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

ANDERSON, KENNETH CARL, West Allis, Wis. (Age 28.) Refers to J. J. Doland, W. C. Huntington.

ANDERSON, WILBUR STOCKER, Western Springs, Ill. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

ATESHOGLOU, ANASTASIS DEMETRE, Urbana, Ill. (Age 26.) Refers to E. E. Bauer, J. S. Crandell, H. Cross, W. C. Huntington, C. E. Palmer.

BALL, NICHOLAS, JR., Block Island, R.I. (Age 23.) Refers to C. D. Billmyer, F. W. Stubbs, Jr.

BANKS, THOMAS GRAY, Oklahoma City, Okla. (Age 50.) Cons. Engr. Refers to J. F. Brookes, L. M. Bush, R. V. Lindsey, C. W. McFerron, W. E. Price.

BARRETT, WILLIAM SCOTT, Austin, Tex. (Age 23.) Refers to P. M. Ferguson, J. A. Focht.

BEALL, WILLIAM STANLEY, Pittsburgh, Pa. (Age 20.) Refers to F. M. McCullough, C. B. Stanton.

BEARD, ABNER HAMILTON, JR., Jefferson City, Mo. (Age 24.) Asst. Public Health Engr., State Board of Health of Missouri. Refers to R. B. B. Moorman, H. Rubey.

BEATTIE, NORVAL WILSON, Columbia, Mo. (Age 24.) Refers to R. B. B. Moorman, H. Rubey.

BECK, JOSEPH FREDERICK, New York City. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

BENGI, NECDET AHMED, New York City. (Age 25.) Refers to A. Casagrande, G. M. Fair, A. Haertlein, E. S. Sheiry.

BENTLEY, HAROLD ROY, Webster Groves, Mo. (Age 22.) Res. Engr. with Russell & Axon, on sewer construction. Flat River, Mo. Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton.

BERG, JOHN, JR., Bismarck, N.Dak. (Age 29.) Asst. Engr., North Dakota Dept. of

Highways. Refers to J. M. Brown, E. R. Griffin, W. N. Lovejoy, C. E. Mannerow.

BERGER, HERMAN WILLIAM, JR., Baltimore, Md. (Age 23.) Refers to H. R. Hall, A. H. Hartman, S. S. Steinberg.

BIGELOW, LAWRENCE NEAL, Lawrence, Kans. (Age 21.) Refers to G. W. Bradshaw, W. C. McNown, F. A. Russell.

BLOSS, JOHN MILNOR, Springfield, Ill. (Age 30.) Mun. Engr., The W. Q. O'Neall Co. of Illinois. Refers to G. H. Baker, M. C. Noble, C. M. Slaymaker, R. V. Tilly, R. L. Whannel.

BOEHLKE, JOHN HENRY, Plainview, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler.

BONUCCHI, VICTOR PAUL, Standard, Ill. (Age 23.) Refers to H. E. Babbitt, E. E. Bauer, W. A. Oliver, T. C. Shedd, C. C. Wiley.

BRANDT, CHESTER CHARLES, Galesburg, Ill. (Age 24.) Refers to N. D. Morgan, C. E. Palmer.

BRESSI, DOMINIC JOHN, Brooklyn, N.Y. (Age 21.) Refers to J. K. Finch, J. A. Oakey.

BRETSCHER, ERWIN RUDOLPH, St. Louis, Mo. (Age 23.) Refers to R. B. B. Moorman, H. Rubey.

BROSIO, ALFRED LOUIS, San Francisco, Calif. (Age 21.) Refers to B. A. Etcheverry, C. T. Wiskocil.

BROWN, WILLIAM YATES, Kansas City, Mo. (Age 21.) Refers to G. W. Bradshaw, J. O. Jones, W. C. McNown, N. T. Veatch, Jr.

BULL, THOMAS EMERY, Oregon, Ill. (Age 24.) Refers to N. D. Morgan, C. E. Palmer.

BURNS, ROBERT EUGENE, Galena, Ill. (Age 23.) Refers to J. S. Crandell, G. W. Pickels, T. C. Shedd.

CALDWELL, CHARLES GEORGE WINTER, Santa Fe, N. Mex. (Age 25.) Refers to J. H. Dorroh, H. C. Neuffer.

CANHAM, CHESTER HAROLD, Virden, Ill. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

CARLSON, ROBERT WILLIAM, Duluth, Minn. (Age 23.) Refers to F. Bass, A. S. Cutler.

CARR, JAMES HENRY, JR., Washington, D.C. (Age 22.) Structural Engr., Timber Eng. Co. Refers to J. B. Babcock, 3d, T. R. Camp, F. J. Hanrahan, J. D. Mitsch, C. M. Spofford.

CARR, JOHN ROLAND, Cheyenne, Wyo. (Age 34.) Designer (Bridge), Wyoming State Highway Dept. Refers to E. W. Burritt, W. H. Fisher, R. D. Goodrich, N. T. Olson, H. T. Person, Z. E. Zevison, P. A. Upp, N. Williams.

CAULEY, PHIL WILSON, Fordwick, Va. (Age 21.) Refers to R. B. H. Begg, F. J. Sette.

CISLER, LEWIS DELBERT, Sharon, Ohio. (Age 22.) Refers to C. T. Morris, J. C. Prior, R. C. Sloane.

CLARKE, JOHN CLINTON, Montgomery, Ala. (Age 25.) Asst. San. Engr., Alabama State Board of Health. Refers to A. C. Barrow, J. A. C. Callan, T. H. Milford.

CLOSSON, EDGAR GEORGE, Logansport, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

COATES, JACK GILMER, Bartlesville, Okla. (Age 25.) Refers to R. B. B. Moorman, H. Rubey.

COPELAND, CHARLES FAULKNER, Junction City, Calif. (Age 24.) Transitman and Res. Engr., Pacific Gas & Elec. Co., Land and Constr. Depts. Refers to T. J. Corwin, Jr., C. Derleth, Jr., B. A. Etcheverry, H. W. Haberkorn.

CRANDALL, LEE WALTER, Milwaukee, Wis. (Age 24.) Asst. Instructor in Topographic Eng., Univ. of Wisconsin. Refers to D. W. Mead, F. E. Turneaure, L. F. Van Hagan.

CRAWFORD, LEONARD KENNETH, Springfield, Ill. (Age 24.) Jun. Engr. with Wood, Walraven & Tilly, Civ. and Structural Engrs. Refers to A. Boyd, E. F. Chandler, R. V. Tilly.

CRAWSHAW, ARTHUR CLYDE, San Francisco, Calif. (Age 38.) Regional Engr., U. S. Dept. of Agriculture, Resettlement Administration. Refers to A. E. Crenshaw, J. H. Diehl, C. R. Goodrich, J. B. Hamilton, J. R. Jahn, J. E. Jones, F. A. Kittredge.

DALLAS, JAMES LORNIE, Beverly, Mass. (Age 23.) Refers to H. B. Alvord, G. M. Fair, A. Haertlein.

DAVENPORT, ROBERT EUGENE, Buffalo, N.Y. (Age 26.) Refers to C. A. Ellis, R. B. Wiley.

DE CARLO, JAMES FRANCIS ANTHONY, Orange, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

DECHAENE, ROLAND JULES, Elizabeth, N.J. (Age 21.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

DEISENROTH, JOHN CARL, Rock Island, Ill. (Age 23.) Refers to W. C. Huntington, T. C. Shedd.

DENZER, EDWARD MICHAEL, Brooklyn, N.Y. (Age 22.) Refers to H. R. Codwise, H. P. Hammond.

DEWAN, THOMAS PAUL, Wilkinsburg, Pa. (Age 22.) Refers to E. E. Bauer, J. A. Folse, L. D. Gayton, W. C. Huntington, G. B. Massey, T. C. Shedd, J. Vawter.

DODDS, ROBERT HUNGERFORD, Ames, Iowa. (Age 22.) Refers to T. R. Agg, R. A. Caughey, A. H. Fuller, F. Kerekes, A. Marston.

DONG, YEN HONG, Canton, China. (Age 28.) Refers to W. Allan, R. E. Goodwin, L. C. Pope, T. H. Prentice, J. C. Rathbun.

D'ONOFRIO, MICHAEL DANIEL, Orange, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

DRACHMAN, ALLEN OGDEN RICE, Midland, Calif. (Age 21.) Refers to E. S. Borgquist, F. C. Kelton.

DRISCOLL, DONALD, Aberdeen, S.Dak. (Age 22.) Refers to A. A. Chenoweth, E. D. Dake.

DRISKELL, JOHN JOSEPH, Ambridge, Pa. (Age, 25.) Refers to E. F. Coddington, G. E. Large, C. T. Morris, J. C. Prior, R. C. Sloane.

DRURY, JOSEPH DONAHUE, New Haven, Conn. (Age 35.) Asst. Highway Engr., Connecticut State Highway Dept. Refers to C. S. Farnham, C. L. Nord, H. J. Tippet, R. S. Treat, J. F. Willis, J. B. Wright.

EBERHART, ALANSON CLYDE, Stamford, Conn. (Age 39.) Refers to J. D'Esposito, C. M. Duff, R. W. Emmert, C. E. Mickey, E. E. Stetson.

EDMONSTON, THOMAS RITCHIE, Chevy Chase, Md. (Age 28.) Clerk, Treasurer's Office, Reconstruction Finance Corporation, Washington, D.C., accounting work. Refers to J. C. Hoyt, J. R. Lapham, M. Macartney, R. C. Marshall, Jr., D. H. Sawyer.

ELAM, DANIEL FRANK, Los Angeles, Calif. (Age 21.) Refers to G. W. Bradshaw, W. C. McNown.

ELDEN, WILLIAM ROBERT, JR. Decatur, Ill. (Age 24.) Refers to H. E. Babbitt, J. J. Doland, W. C. Huntington, W. A. Oliver, G. W. Pickels.

ELDER, GEORGE WESLEY, San Fernando, Calif. (Age 32.) Chf. of Survey Party, California Div. of Highways, Dist. VII. Refers to T. J. Allen, S. V. Cortelyou, F. B. Cressy, A. N. George, A. D. Griffin, G. H. Lamb, Jr., R. L. Stump.

ELGIN, ROBERT LEWIS, Okmulgee, Okla. (Age 23.) Student Engr., Refinery Div., Phillips Petroleum Co. Refers to C. E. S. Bardsley, H. C. Beckman, H. C. Bolon, J. B. Butler.

EPPLER, WILLIAM GEORGE, Bloomfield, N.J. (Age 21.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

ERICKSON, DONALD ALBERT, Minneapolis, Minn. (Age 21.) Refers to F. Bass, A. S. Cutler.

ERICKSON, LINNE FELIX, Moscow, Idaho. (Age 25.) Refers to J. E. Buchanan, I. N. Carter, I. C. Crawford, J. W. Howard.

EVANS, WILLIAM JASON, Berkeley, Calif. (Age 35.) Field Engr., Strauss & Paine, Inc. Refers to W. H. Arata, R. G. Cone, F. W. Crocker, J. D. Galloway, C. E. Paine, H. E. Squire.

EWOLDT, CHARLES PARKER, Crawfordsville, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

FAUSTMAN, DANIEL JACKSON, Sacramento, Calif. (Age 21.) Refers to C. Derleth, Jr., C. G. Hyde.

FELD, MYRON XANE, Brooklyn, N.Y. (Age 22.) Eng. Interne, Dept. of Water Supply, Design Div., New York City. Refers to W. Allan, R. E. Goodwin.

FELLOURIS, JOHN HARRY, New Bedford, Mass. (Age 21.) Refers to J. B. Babcock, 3d, J. D. Mitsch.

FEUDALE, FRANCIS JOSEPH, Brooklyn, N.Y. (Age 21). Refers to J. J. Costa, A. V. Sheridan.

FEY, REGIS FLORIAN, Pittsburgh, Pa. (Age 28.) Refers to C. G. Dunnells, F. J. Evans, F. M. McCullough, C. E. Portas, C. B. Stanton, H. A. Thomas.

FIFE, ROWLAND WILLIAMS, Window Rock, Ariz. (Age 23.) Refers to J. H. Dorroh, H. C. Neuffer.

FLANNAGAN, OSCAR BROADUS, Havana, Cuba. (Age 40.) Chf. Engr., Celestino Joristi Y Compania, Havana, Cuba. Refers to E. J. Chibas, C. C. FitzGerald, J. Garcia Montes, M. Villa Rivera, R. S. Webster.

FLETCHER, JOSEPH FRANCIS, Xenia, Ohio. (Age 22.) Refers to C. J. Belz, J. J. Chamberlain, Jr., B. T. Schad.

FONTENOT, OCTAVE LEON, Wharton, Tex. (Age 22.) Refers to B. W. Pegues, F. F. Pillet.

FOWLER, HAROLD DIX, Stanford University, Calif. (Age 25.) Refers to S. B. Morris, L. B. Reynolds, J. B. Wells.

FRANKLIN, RICHARD JACCOUD, Chicago, Ill. (Age 28.) Refers to H. E. Babbitt, J. J. Doland, W. C. Huntington, W. H. Rayner, T. C. Shedd, C. C. Wiley.

FRANZEN, EARL THEODORE, Palisade, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler.

FRICKLAND, LOREN LILLIARD, Roseau, Minn. (Age 21.) Refers to F. Bass, A. S. Cutler.

FRIEDMAN, SAM STANLEY, Brooklyn, N.Y. (Age 25.) Asst. Engr., New York City Park Dept., Topographical Div., being Chf. of Party on topographical surveys. Refers to H. P. Hammond, E. J. Squire.

FUCIK, EDWARD MONTFORD, Highland Park, Ill. (Age 23.) Refers to A. Casagrande, E. J. Fucik, A. Haertlein.

GADE, RICHARD HENRY, Lancaster, Pa. (Age 21.) Refers to J. J. Doland, T. C. Shedd.

GAIN, EDWARD JACOB ARTHUR, St. Louis, Mo. (Age 36.) Senior Civ. Engr., Board of Public Service, Sewers and Paving Sec., City of St. Louis. Refers to E. E. Bloss, H. E. Frech, C. A. Koerner, L. A. Pettus, E. O. Sweetser, J. L. Van Ornum, L. R. Viterbo.

GALE, CLARENCE STEPHENS, JR., Raleigh, N.C. (Age 21.) Refers to W. G. Geile, T. S. Johnson, C. M. Lambe, C. L. Mann, H. Tucker.

GATES, ROBERT HOWARD, New Lebanon, Ohio. (Age 22.) Refers to C. J. Belz, J. J. Chamberlain, Jr., B. T. Schad.

GLASS, SHERMAN, Brooklyn, N.Y. (Age 22.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison, M. H. Van Buren, J. P. J. Williams.

GLOVER, WARREN ELWOOD, Bedford, Ind. (Age 22.) Refers to N. D. Morgan, C. E. Palmer.

GOLDBERG, JOSEPH JOSHUA, New York City. (Age 23.) Refers to W. Allan, T. H. Prentice.

GODALE, ARTHUR WORTHINGTON, Dover, N.J. (Age 24.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

GOODELL, JOHN MERRILL, Beardstown, Ill. (Age 23.) Refers to J. J. Doland, T. C. Shedd.

GOSSARD, MYRON LEE, Urbana, Ill. (Age 23.) Refers to W. C. Huntington, T. C. Shedd.

GRANGER, LAURENCE FREDERIC, Westborough, Mass. (Age 26.) Refers to J. W. Howe, C. F. Meyer.

GREEN, GILES GEORGE, Jamaica, N.Y. (Age 20.) Refers to R. C. Brumfield, F. E. Foss.

GREEN, RICHARD STEDMAN, Somerville, Mass. (Age 23.) Refers to G. M. Fair, A. Haertlein.

GUBBALIS, SOPHOCLES, Canee, Isle de Crete, Greece. (Age 22.) Refers to J. S. Crandell, H. Cross, J. J. Doland, W. C. Huntington, C. C. Wiley.

HALE, LUCIUS MELVIN, Logan, Utah. (Age 24.) Refers to H. F. Blaney, H. S. Carter, G. D. Clyde, O. W. Israelsen, H. R. Kepner, F. C. Sobey.

HANCOCK, HUGH MARION, IDLEWILD, N.C. (Age 34.) Asst. Project Engr., Blue Ridge Parkway, Bureau of Public Roads. Refers to O. V. Adams, W. M. Austin, J. D. Cockey, A. Haygard, J. H. Murdough, H. N. Roberts.

HARDY, WILLIAM RALPH, Dallas, Tex. (Age 25.) Refers to G. M. Fair, A. Haertlein.

HARRIS, PHILIP CHARLES, Ceres, Calif. (Age 22.) Refers to B. Jameyson, C. T. Wiskocil.

HARRISON, JOSIAH JAMES, Lindsay, Okla. (Age 22.) Refers to J. F. Brookes, B. S. Myers, R. R. Tway, N. E. Wolfard.

HARRISON, ROBERT STEWART, Manitou Springs, Colo. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

HASTINGS, ROBERT FRANK, Kenosha, Wis. (Age 22.) Refers to R. P. Hoelscher, N. D. Morgan, C. E. Palmer.

HEIL, BOYCE FERDINAND, Houston, Tex. (Age 26.) Field Engr., Shell Refinery, Houston, Tex. Refers to L. E. Grinter, J. T. L. McNew, J. J. Richey, C. E. Sandstedt.

HEITZ, WILLIAM SNEDDON, Logan, Utah. (Age 24.) Refers to H. S. Carter, G. D. Clyde, O. W. Israelsen, H. R. Kepner.

HELM, JOHN DEAN, JR., Minneapolis, Minn. (Age 21.) Refers to F. Bass, A. S. Cutler.

HOOK, CLARENCE MERTON, Templeton, Mass. (Age 24.) Refers to C. D. Billmyer, J. L. Murray, F. W. Stubbs, Jr.

HOOKE, ALBERT CHARLES, Baltimore, Md. (Age 22.) Refers to T. F. Comber, Jr., T. F. Hubbard, F. W. Medaugh, J. T. Thompson.

HOOPER, WILLIAM THOMAS FRANCIS, JR., Chicago, Ill. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

INGWALSON, CARL FREDRICK, Mankato, Minn. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

JACKSON, JAMES ALLEN, Rensselaer, Ind. (Age 24.) Refers to G. M. Fair, W. E. Howland, H. G. Rogers, R. B. Wiley.

JOBUSCH, FRED HENRY, Collinsville, Ill. (Age 21.) Refers to N. D. Morgan, C. E. Palmer.

JOHNSON, FRED ATKINS, Buffalo, N.Y. (Age 22.) Refers to R. B. B. Moorman, H. Rubey.

JOHNSON, SAMUEL ARVID, JR., Philadelphia, Pa. (Age 22.) Student Field Engr., Chicago Bridge & Iron Co. Refers to T. R. Lawson, H. O. Sharp, E. R. Wiseman.

JORDAN, JAMES WELLS, San Francisco, Calif. (Age 25.) Refers to F. Doughty, J. B. Wells.

KACHORSKY, MICHAEL SERGE, Manville, N.J. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

KELLER, LYNDON MAYNARD, Brooklyn, N.Y. (Age 22.) Refers to W. S. Evans, G. M. Fair, A. Haertlein.

KEVAN, GLENN HERMAN, Topeka, Kans. (Age 27.) Asst. Designer, Kansas State Highway Dept. Refers to E. S. Elcock, F. W. Epps, P. G. Martin.

KIEL, PAUL MARTIN, Tiffin, Ohio. (Age 23.) Refers to J. Montz, C. T. Morris, J. C. Prior.

KIEPE, QUINTON RICHARD, Newark, N.J. (Age 21.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

KINGMAN, DEAN STANLEY, Chicago, Ill. (Age 24.) Refers to T. C. Shedd, C. C. Wiley.

KLINGEL, THOMAS RALPH, St. Paul, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler, L. G. Straub.

KOOGLER, JACK GRAHAM, Albuquerque, N.Mex. (Age 23.) Refers to J. H. Dorroh, H. C. Neuffer.

KRAFT, ELMER ALEXANDER, Gilman, Ill. (Age 22.) Refers to J. S. Crandell, T. C. Shedd.

KRASNITSKY, HYMEN HAROLD, Chicago, Ill. (Age 23.) Refers to J. G. Bennett, D. C. Jackson, Jr.

LANTAY, GEORGE SYLVESTER, New York City. (Age 24.) Refers to J. J. Costa, A. V. Sheridan.

LEFEBER, FRANCIS FREDERICK, New York City. (Age 21.) Refers to R. C. Brumfield, F. E. Foss.

LEGGETT, JAMES LLEWELLYN, JR., Sewickley, Pa. (Age 20.) Refers to W. J. Carrel, D. V. Terrell.

LIEBER, ALBERT CARL, JR., Dover, Ohio. (Age 42.) Major, Corps of Engrs., U. S. Army, being Area Engr. in Zanesville Engr. Dist. Refers to J. M. Belknap, G. H. Friend, W. Gerig, L. C. Hill, J. D. Justin, W. H. McAlpine, R. R. Philippe, E. L. Winslow, Jr.

LIEBERMAN, NORMAN, Columbus, Ohio. (Age 21.) Refers to J. M. Montz, C. T. Morris, J. C. Prior, J. R. Shank, C. E. Sherman.

LINSLEY, RAY KEYES, JR., New York City. (Age 20.) Refers to A. W. French, J. W. Howe, A. J. Knight.

LIVESAY, P. CRAIG, College Station, Tex. (Age 25.) Texas Agricultural and Mechanical Coll. Refers to L. E. Grinter, J. T. L. McNew.

LOGAN, SAMUEL TOLBERT, Old Hickory, Tenn. (Age 26.) Refers to N. W. Dougherty, A. S. Fry.

LO PICCOLO, ANTHONY ALOYSIUS, Brooklyn, N.Y. (Age 26.) Refers to D. M. Burmister, J. K. Finch, J. A. Oakey.

LO PREST, ANTONINO, San Francisco, Calif. (Age 37.) Manufacturer's Agent for and Manufacturer of miscellaneous water-treating and purification and power-plant equipment, etc. Refers to B. Benas, C. C. Kennedy, N. C. Raab, J. Rosenwald, R. D. Wichman.

MCCASLIN, WALTER ROY, 2d, Los Angeles, Calif. (Age 27.) Refers to R. M. Fox, D. M. Wilson.

MCCORD, MARSHAL, Baltimore, Md. (Age 20.) Refers to T. F. Hubbard, J. T. Thompson.

MCDOWELL, FRANCIS PAUL, Cincinnati, Ohio. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

MCKEE, ROBERT WILSON, Columbus, Ohio. (Age 20.) Refers to J. M. Montz, C. T. Morris, J. C. Prior, C. E. Sherman, R. C. Sloane

MCLEOD, ROBERT JOHN, Edmonston, Md. (Age 20.) Refers to H. R. Hall, S. S. Steinberg.

MAEVIS, ALFRED CORNELIUS, Richmond Hill, N.Y. (Age 20.) Refers to H. R. Codwise, H. P. Hammond.

MAGUIRE, WALTER JOSEPH, Providence, R.I. (Age 22.) Refers to J. D. Mitsch, C. M. Spofford.

MAINES, THOMAS RICHARD, Knoxville, Tenn. (Age 38.) Sales Engr., Wilson-Weesner-Wilkinson Co., detailing, estimating, designing, etc. Refers to E. S. Birkenwald, A. Bonnyman, O. W. Irwin, K. C. Roberts, W. S. Trimble, E. B. Wilkinson.

MAISH, FREDERIC FUDGE, Tipton, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

MALONEY, THOMAS FRANCIS, Brooklyn, N.Y. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

MARK, DONALD WILLIAM, St. Paul, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler.

MARUM, EDMOND FRANCIS, Cave Creek, Ariz. (Age 22.) Refers to E. S. Borgquist, F. C. Kelton, J. C. Park.

MASON, DONALD DWIGHT, Kouts, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

MAXWELL, GEORGE HENRY, JR., Lexington, Tenn. (Age 24.) Refers to N. W. Dougherty, G. E. Tomlinson.

MAYER, DAVID, New York City. (Age 21.) Refers to A. Casagrande, A. Haertlein.

MEENAN, JAMES GALLAGHER, Pittsburgh, Pa. (Age 26.) Refers to F. M. McCullough, C. B. Stanton, H. A. Thomas.

MENG, MAURICE, Cambridge, Mass. (Age 23.) Refers to G. M. Fair, A. Haertlein.

MERRYMAN, HAROLD WOODROW, Corvallis, Ore. (Age 24.) Refers to F. Merryfield, C. A. Mockmore.

MILHOLLIN, AUSTIN BARLOW, Olney Springs, Colo. (Age 21.) Refers to E. O. Bergman, R. L. Downing, C. L. Eckel, E. W. Raeder.

MILLER, MERLE EUGENE, Milwaukee, Wis. (Age 24.) With Layne-Northwest Co. Refers to C. A. Ellis, R. B. Wiley.

MITCHELL, WILLARD ORVILLE, Indianapolis, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

MOORE, PAUL LEHMANN GLENN, Chicago, Ill. (Age 31.) Refers to G. B. Massey, J. C. Penn., R. L. Stevens.

MOREHEAD, HERBERT LESLIE, JR., Cedar Rapids, Iowa. (Age 21.) Refers to R. B. Kittredge, B. J. Lambert, H. E. Wessman.

MORRISON, HERBERT JOHN, Tallahassee, Fla. (Age 25.) Draftsman, Florida State Road Dept. Refers to T. M. Lowe, P. L. Reed, W. L. Sawyer.

MOSER, FRANCIS, Albuquerque, N.Mex. (Age 22.) Refers to J. H. Dorroh, H. C. Neuffer.

MOWRER, JESSE DEE, Albuquerque, N.Mex. (Age 22.) Refers to J. H. Dorroh, H. C. Neuffer.

MUHLENBRUCH, CARL WILLIAM, JR., Decatur, Ill. (Age 21.) Refers to W. C. Huntington, T. C. Shedd.

NAGLER, MAURICE, New York City. (Age 23.) Refers to L. C. Pope, J. C. Rathbun.

NAHMIAS, HAROLD ALBERT, New York City. (Age 21.) Refers to W. Allan, W. L. Willig.

NELSON, JACK MINOR, Pigeon Key, Fla. (Age 25.) With Overseas Road and Toll Bridge Dist., on Overseas Highway, Key West to Miami. Refers to W. W. Fineren, T. M. Lowe, P. L. Reed.

NELSON, JOHN EMIL, Galveston, Tex. (Age 24.) Refers to E. C. H. Bantel, J. A. Focht.

NEWMYER, LOWELL, Central City, Nebr. (Age 21.) Refers to C. M. Duff, M. I. Evinger, D. H. Harkness, H. J. Kesner, C. E. Mickey.

NORTON, JOHN COMSTOCK, Detroit, Mich. (Age 27.) Member of firm, Heldt & Norton, Residence Contrs., Royal Oak, Mich.; also (spare time) Structure Designer for reinforced concrete with Smith, Hinchman & Grylls, Detroit. Refers to F. C. McMath, R. L. McNamee, F. C. Taylor.

O'BRIEN, JACK CHARLES, Dayton, Ohio. (Age 21.) Refers to J. J. Chamberlain, Jr., B. T. Schad.

OKUN, DANIEL ALEXANDER, Brooklyn, N.Y. (Age 20.) Refers to R. C. Brumfield, F. E. Foss.

OLSON, ELMER HAROLD, Norfolk, Nebr. (Age 22.) Refers to J. J. Doland, T. C. Shedd.

OTTINGER, NEWTON HAROLD, Oskaloosa, Kans. (Age 28.) Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, F. W. Green, C. V. Mann.

PEARSON, CLARENCE RUSSELL, Bigfork, Minn. (Age 24.) Refers to F. Bass, A. S. Cutler.

PELOCHINO, EDWARD JOHN, Brooklyn, N.Y. (Age 24.) Refers to H. S. Carter, G. D. Clyde, O. W. Israelsen.

PERUGGI, FRANK ERNEST, Brooklyn, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

PETERSON, DEL ROY CARL ROGER, Minneapolis, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler.

PIETRANGELO, ALBERT PHILIP, Smithfield, Ohio. (Age 22.) Refers to J. M. Montz, C. T. Morris, J. C. Prior.

POPE, WALTER JOSEPH, Bronx, N.Y. (Age 20). Refers to J. J. Costa, A. V. Sheridan.

OSTON, RICHARD FRANCIS, Pierre, S.Dak. (Age 30.) With State Board of Health. Refers to G. M. Fair, A. H. Holt, F. T. Mavis, H. G. Rogers, A. H. Wieters, C. C. Williams.

PUTERBAUGH, JACK DUDLEY, Centerville, Ohio. (Age 23.) Refers to C. J. Belz, J. J. Chamberlain, Jr., B. T. Schad.

RAMSEY, JAMES BUTLER, Topeka, Kans. (Age 26.) Refers to G. W. Bradshaw, W. C. McNown.

RATHBURN, ROBERT EDISON, Boulder, Colo. (Age 23.) Refers to C. L. Eckel, E. W. Raeder.

RAWLINS, CARL ELBERT, McCamey, Tex. (Age 22.) Refers to E. C. H. Bantel, P. M. Ferguson, J. A. Focht.

REINHARDT, ARTHUR WILLIAM, Pasadena, Calif. (Age 22.) Refers to C. G. Hyde, C. T. Wiskocil.

RENNER, WALTER ADOLF, Aurora, Ill. (Age 22.) Refers to J. J. Doland, W. C. Huntington, T. C. Shedd.

REYNOLDS, CHESTER THOMAS, Richmond, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

RHODE, ROBERT BERG, Duluth, Minn. (Age 23.) Refer to F. Bass, A. S. Cutler.

RIDDLE, MARION ALBERTSON, St. Joseph, Mo. (Age 22.) Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

RIZZI, ANTHONY VINCENT, Jamaica, N.Y. (Age 20.) Refers to W. Allan, R. E. Goodwin.

ROBBINS, EDWIN GUY, Dwight, Ill. (Age 21.) Refers to E. E. Bauer, W. C. Huntington, W. A. Oliver, T. C. Shedd, C. C. Wiley.

ROBLEY, GRANT, Corvallis, Ore. (Age 27.) Instructor, Civ. Eng. Dept., Oregon State Coll. Refers to G. W. Holcomb, F. Merryfield, C. A. Mockmore, H. A. Rands, W. L. Sharp.

ROLLER, CHARLES ELMER, JR., Philadelphia, Pa. (Age 22.) Refers to H. C. Berry, W. H. Chorlton, W. S. Pardoe, F. P. Witmer.

ROLLIN, LAWRENCE WILLIAM, West Duluth, Minn. (Age 23.) Refers to F. Bass, A. S. Cutler, L. G. Straub.

ROSS, ANDREW WILSON, East Chicago, Ind. (Age 24.) Refers to C. A. Ellis, R. B. Wiley.

ROWNY, EDWARD LEON, Baltimore, Md. (Age 20.) Refers to T. F. Comber, Jr., J. T. Thompson.

RUBEY, THOMAS HARDEN, Columbia, Mo. (Age 21.) Refers to R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

SACHS, ALEXANDER FREDERIC, Kansas City, Mo. (Age 48.) Highway Engr. and Surveyor, Jackson County, Mo. Refers to J. F. Brown, W. G. Fowler, F. S. Gilmore, W. M. Spann, E. M. Stayton, T. J. Strickler, N. T. Veatch, Jr.

SANTORA, HUGO RENATA, Jersey City, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

SARVEN, HARVEY WARD, East Orange, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr., A. P. Richmond, Jr.

SAVIDGE, PAUL SHEPPARD, Tacoma, Wash. (Age 52.) Vice-Pres. and part owner, Industrial Engrs. & Contrs., Inc. Refers to J. Crosby, C. D. Forsbeck, O. H. Hallberg, W. A. Kunigk, G. L. Parker, W. C. Raleigh, W. J. Ryan.

SAXTON, REN GEORGE, Stillwater, Okla. (Age 50.) Refers to T. R. Agg, J. F. Brookes, C. M. Cade, V. H. Cochrane, L. E. Conrad, J. E. Kirkham, E. R. Stapley.

SCHAFFEL, FRANCIS LEWIS, Richmond Hill, N.Y. (Age 21.) Refers to W. Allan, J. C. Rathbun.

SCHEIBLE, ALBERT EDWARD, Cleveland, Ohio. (Age 32.) Prin. Asst. Engr. with R. D. MacDowell on sanitary engineering improvements. Refers to W. W. Anderson, H. W. Green, W. L. Leach, R. F. MacDowell, H. C. Plummer, C. E. Sherman.

SCHER, MARVIN BERTRAM, Newark, N.J. (Age 20.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

SCHMIDT, RALPH FREDERICK, Wright City, Mo. (Age 24.) Refers to R. B. B. Moorman, H. Rubey.

SCHOLER, WALTER, JR., Lafayette, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

SCOTT, JAMES MORRISON, Carnegie, Pa. (Age 22.) Refers to R. L. Downing, C. L. Eckel.

SERVET, ABDURRAHIM, Chicago, Ill. (Age 24.) Refers to F. J. Converse, R. R. Martel, W. W. Michael, W. C. Sadler, F. Thomas, J. S. Worley.

SHAHAN, EVERETT TERRY, Wink, Tex. (Age 24.) Rotary Helper, Humble Oil & Refining Co. Refers to O. V. Adams, J. H. Murdough, G. W. Parkhill.

SIMONINI, CONSTANT LEONARD, Providence, R.I. (Age 22.) Refers to C. D. Billmyer, J. L. Murray, F. W. Stubbs, Jr.

SKINNER, HARRY ELLSWORTH, Aledo, Ill. (Age 21.) Refers to H. E. Babbitt, E. E. Bauer, W. C. Huntington, G. W. Pickels, T. C. Shedd.

SMITH, JAMES ROBERT, San Carlos, Ariz. (Age 21.) Refers to J. H. Dorroh, H. C. Neuffer.

SODERBERG, ARTHUR DARWIN, Casper, Wyo. (Age 23.) Refers to R. L. Downing, C. L. Eckel.

SODERBERG, RICHARD GOTTFRIED, Rock Island, Ill. (Age 23.) Asst. Eng. Draftsman, U. S. Army Engrs., Rock Island, Ill. Refers to F. Bass, A. S. Cutler, L. G. Straub.

SPHAR, LELAND LAWRENCE, Donora, Pa. (Age 24.) Refers to F. M. McCullough, C. B. Stanton.

STEVENS, VICTOR GEORGE, NEWARK, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

STEVENSON, ALBERT HENRY, Brooklyn, N.Y. (Age 23.) Refers to G. M. Fair, A. Haertlein, W. C. Taylor.

STIPP, JOHN ROBERT, Champaign, Ill. (Age 22.) Refers to H. E. Babbitt, W. C. Huntington, G. W. Pickels, T. C. Shedd, J. Vawter.

STOUT, THURMAN ALLEN, Catlettsburg, Ky. (Age 37.) Mgr., Catlettsburg, Kenova & Ceredo Water Co. Refers to T. J. Blair, Jr., L. V. Carpenter, R. P. Davis, J. E. Settle, M. W. Smith, Jr.

SUBKOWSKY, ABRAHAM, Bronx, N.Y. (Age 22.) Refers to W. Allan, L. C. Pope, W. L. Willig.

SUTHERLAND, LEWIS BIRD, Boulder, Colo. (Age 36.) Asst. Prof. of Arch. Eng., Univ. of Colo. Refers to W. E. Brockway, R. L. Downing, C. L. Eckel, N. D. Morgan, C. E. Palmer, A. O. Ridgway, A. W. Simonds.

SWEET, CHARLES ALVIN, Indio, Calif. (Age 27.) Senior Inspector, Metropolitan Water Dist. of Southern California. Refers to G. E. Baker, R. C. Booth, R. B. Diemer, A. Jones, D. H. Rutledge, O. J. Schieber.

SYNDENNIS, ELMER JOSEPH, Tompkinsville, N.Y. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

TAYLOR, ERNEST WILLIAM, JR., East Cleveland, Ohio. (Age 22.) Refers to G. E. Barnes, M. S. Douglas, G. B. Earnest, F. L. Plummer, G. B. Sowers.

TENTSCHERT, FRANCIS FERDINAND, Westport, Conn. (Age 25.) Refers to H. N. Lendall, W. Rudolfs.

THOMAS, PAUL LOUIS, Foley, Minn. (Age 23.) Refers to F. Bass, A. S. Cutler, L. G. Straub.

THORSTENSON, FREDERICK WOODARD, St. Paul, Minn. (Age 22.) Refers to F. Bass, A. S. Cutler.

TONDRO, LYMAN WILLIAM, El Centro, Calif. (Age 22.) Refers to E. L. Grant, S. B. Morris, L. B. Reynolds, H. A. Williams.

TOURTELLOT, IRVING WILLIAMS, Greenville, S.C. (Age 23.) Refers to J. B. Babcock, 3d, J. D. Mitsch.

TRAUBE, CLARENCE JAMES BRENDAN, New York City. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

TURNBELL, ROBERT CHARLES, Frankfort, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

TURNER, RALPH RUSSELL, Pierre, S.Dak. (Age 21.) Refers to A. A. Chenoweth, E. D. Dake.

UPP, RONALD JOCELYN, Napoleon, Ohio. (Age 23.) Refers to L. H. Gardner, A. R. Webb.

VALLIS, JOHN NICHOLAS, Athens, Greece. (Age 27.) Asst. Dist. Engr., The Foundation Co. of New York, on Salonika Plain Reclamation Project, being Engr. in charge of construction supplementary works project. Refers to J. S. Crandell, H. Cross, J. J. Doland, G. A. Halkiopulos, W. C. Huntington, E. S. Sheiry.

VARELA, ANTHONY ALOYSIUS, Tenafly, N.J. (Age 22.) Refers to J. J. Costa, A. V. Sheridan.

VERLANGIERI, EDWARD JOSEPH, Orange, N.J. (Age 23.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

VESCO, ARTHUR, Newark, N.J. (Age 25.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

VOGT, JOHN EDWARD, Des Moines, Iowa. (Age 21.) Refers to B. J. Lambert, E. L. Waterman.

WALBERT, THOMAS PAXTON, Little Rock, Ark. (Age 25.) Designer and Computer, Arkansas State Highway Dept. Refers to W. E. Ford, G. L. Fry, N. B. Garver, A. W. Hardy, W. W. Zass.

WARREN, MOULTRIE ALFRED, Byron, Ga. (Age 24.) Refers to R. P. Black, C. D. Gibson, F. C. Snow.

WEBSTER, MARVIN JAMES, Iowa City, Iowa. (Age 33.) Asst. Engr., U. S. Engr. Office. Refers to G. O. Guesmer, J. W. Howe, R. C. Kasel, E. W. Lane, F. T. Mavis.

WEBSTER, RALPH PATTERSON, JR., Lexington, Mass. (Age 21.) Refers to J. B. Babcock, M. J. D. Mitsch.

WEERS, CARL ANTON, Peoria, Ill. (Age 22.) Refers to N. D. Morgan, C. E. Palmer.

WEITH, MELVIN GEORGE, Centerville Station, Ill. (Age 22.) Refers to N. D. Morgan, C. E. Palmer.

WETHERALL, ROBERT, Wilmington, Del. (Age 22.) Refers to T. D. Mylrea, H. K. Preston.

WHITE, PORTER J, Lexington, Ky. (Age 23.) Refers to W. J. Carrel, D. V. Terrell.

WHITMAN, WORSHAM CARROLL, Ft. Worth, Tex. (Age 28.) Instrumentman, State Highway Dept., Div. 2. Refers to C. T. Holmes, M. C. Welborn.

WILLARD, WALTER EDWARD, Highland Park, Ill. (Age 22.) Refers to W. C. Huntington, T. C. Shedd.

WILLARD, WILLIAM RAYMOND, Stanford University, Calif. (Age 26.) Refers to W. L. Fulton, E. L. Grant, J. Nicolet, L. B. Reynolds, J. B. Wells.

WILLIAMS, LEONARD OLIVER, JR., Cheyenne, Wyo. (Age 36.) State San. Engr., Wyoming State Dept. of Health. Refers to G. H. Bishop, P. S. Fox, D. E. Kepner, H. E. Miller, F. C. Roberts, Jr.

WILLIAMS, STEPHEN ASA, Robertson, Mo. (Age 24.) Refers to C. E. Galt, W. W. Horner, E. O. Sweetser.

WILBECK, HORACE MALCOLM, Sacramento, Calif. (Age 26.) Refers to J. J. Gould, J. B. Leonard, S. B. Morris, L. B. Reynolds, J. B. Wells.

WOLF, ROBERT JOSEPH, Denver, Colo. (Age 20.) Refers to E. O. Bergman, R. L. Downing, C. L. Fekel, E. W. Raeder.

WOOD, LEONARD DENNY, JR., West Lafayette, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

WOOD, PAUL BREESE, Paducah, Ky. (Age 27.) Surveyman, U. S. Engrs., Louisville (Ky.) Dist., on flood damage and valuation survey. Refers to S. M. Bailey, J. I. Corbett, R. E. Lawrence, W. H. Noble, F. A. Russell.

WOODWARD, JOHN WESLEY, Susanville, Calif. (Age 23.) Refers to B. A. Etcheverry, H. W. Haberkorn, C. T. Wiskocil.

WRIGHT, CLEMENT WAYNE, Window Rock, Ariz. (Age 37.) Asst. Chf. Engr. and Acting State Administrator, ECW, and Director of Land Use Activities, Rio Grande Dist.; Asst. to Dist. Mgr., Navajo Dist. Refers to F. G. Healy, G. P. T. Howell, W. Johannessen, G. D. Macy, C. L. Meng, R. H. A. Rupkey, W. H. W. Yeo.

YOUNG, DAVID, Memphis, Tenn. (Age 24.) Refers to P. M. Ferguson, S. P. Finch. E. E. Schmied.

ZELNICK, ERNEST WILLIAM, Berwyn, Ill. (Age 20.) With Illinois Water Service Co., Champaign, Ill. Refers to H. E. Babbitt, J. J. Doland, W. C. Huntington, G. W. Pickels.

ZUCK, GERALD W. Kingman, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BOURLAND, CHARLES RICE, Assoc. M., Helen, W.Va. (Elected Dec. 15, 1924.) (Age 42.) Supt., Koppers Coal Co., Helen, W.Va. Refers to J. P. Bonner, W. J. Carrel, H. N. Eavenson, G. M. Kilcarr, L. Llewellyn, J. K. McGrath, H. M. Scott, D. V. Terrell.

BRUSH, GORTON WILLIAM, Assoc. M., East Lansing, Mich. (Elected June 9, 1930.) Age 42.) Vice-Pres. and Gen. Mgr., Michigan Clay Products Corporation, Williamston, Mich. Refers to L. C. Anderson, C. M. Cade, J. H. Cissel, G. C. Dillman, W. C. Giffels, C. A. Melick, R. S. Swinton.

HARTER, ALOYSIUS FRANK, Assoc. M., Safford, Ariz. (Elected May 15, 1917.) (Age 54.) Res. Eng. Inspector for PWA on water and sewer systems, concrete dam, etc. Refers to J. N. Gladding, G. T. Grove, R. A. Hoffman, W. Johannessen, T. Maddock, T. H. Means, T. S. O'Connell.

JOHANNESSEN, WALTER, Assoc. M., Phoenix, Ariz. (Elected Feb. 23, 1932.) (Age 45.) Traveling Engr. Inspector PWA, in charge (under State Engr. Inspector) of inspectors in Arizona and New Mexico. Refers to N. B. Conway, J. B. Girand, J. N. Gladding, R. A. Hoffman, W. W. Lane.

KELLY, IRA DAVID SANKEY, Assoc. M., Chicago, Ill. (Elected Junior July 16, 1928; Assoc. M. April 25, 1932.) (Age 37.) Structural Engr., National Lumber Manufacturers' Association and Timber Eng. Co. (a subsidiary), Washington, D.C., being Office Mgr., Chicago Office. Refers to L. E. Conrad, L. Grover, C. Johnson, P. T. Landsem, I. F. Stern.

MOLINEAUX, CHARLES BORROMEO, Assoc. M., Jamaica, N.Y. (Elected July 16, 1928.) (Age 36.) Chf. Engr., The Arthur A. Johnson Corporation and Necaro Co. Inc. Refers to E. G. Haines, N. L. Hammond, G. P. Hevenor, B. A. Hodgdon, J. H. Myers, R. Ridgway, F. E. Winsor.

PAULUS, RAYMOND LAWRENCE, Assoc. M., Rensselaer, Ind. (Elected July 25, 1932.) (Age 37.) Chf. Engr., W. C. Babcock Grain Co. Refers to L. E. Bogen, F. Kellam, J. W. Moore, F. Nagler, E. D. Roberts, R. Shaw, W. M. White.

PEUGH, VERNE LEON, Assoc. M., Seminoe Dam, Wyoming. (Elected Dec. 22, 1930.) (Age 38.) Chf. Engr., Morrison-Utah-Winston-Lawler, Constrs. on Seminoe Dam for U. S. Bureau of Reclamation. Refers to J. C. Agnew, F. J. Converse. G. W. Hawley, L. T. McAfee, R. R. Martel, W. W. Michael, S. B. Morris, L. S. Oakes, J. L. Savage, F. Thomas, R. White.

THELIN, CARL MILO, Assoc. M., Ft. Worth, Tex. (Elected Oct. 29, 1924.) (Age 36.) Designing Engr., City of Ft. Worth. Refers to O. E. Carr, S. W. Freese, W. Grant, J. B. Hawley, W. O. Jones, D. L. Lewis, D. C. Lipscomb, M. C. Nichols.

WILLIAMS, EUGENE LINGENFELTER, Assoc. M., Columbia, Mo. (Elected Oct. 15, 1923.) (Age 45.) Supt. of Constr., State Bldg. Comm., Jefferson City, Mo. Refers to H. C. Beckman, L. R. Bowen, W. T. Brooks, N. C. Grover, C. A. Haskins, E. E. Howard, J. C. Hoyt, C. E. Jacoby, A. H. Kindrick, F. Kersting, N. T. Veatch, Jr., E. C. L. Wagner.

FROM THE GRADE OF JUNIOR

AFRICANO, ALFRED, Jun., New York City. Elected April 28, 1933.) (Age 29.) Asst. Engr. Interborough Rapid Transit Co. Refers to O. G. H. Buettner, C. E. Carpenter, F. W. Gardiner, G. H. Pegram, D. C. Waite.

CLEMENTS, JAMES STRONG, JR., Jun., Hondo, Tex. (Elected Nov. 15, 1926.) (Age 33.) Asst. Res. Engr., Texas State Highway Dept. Refers to R. A. Bossy, D. G. McKim, J. T. L. McNew, J. J. Richey, J. G. Rollins.

DISARIO, GABRIEL MICHAEL ANTHONY, Jun., Caracas, Venezuela. (Elected Oct. 1, 1928.) (Age 30.) Chf. of San. Div., Ministry of Public Works, Venezuela. Refers to E. V. Barrett, J. M. Bayot, G. C. Bunker, V. de Chelminski, J. M. Ibarra Cerezo, J. R. Stubbins, F. J. Sucre.

GHIGLIONE, ANGELO FRANCESCO, Jun., McKinley Park, Alaska. (Elected Oct. 26, 1931.) (Age 28.) Asst. Supt., Alaska Road Comm., Anchorage, Alaska. Refers to G. E. Hawthorn, A. L. Miller, C. C. More, R. G. Tyler, M. D. Williams.

GRAHAM, HARRY EDWARD, Jun., Maracaibo, Venezuela. (Elected Oct. 26, 1931.) (Age 30.) Res. Engr., Mene Grande Oil Co. Refers to F. L. Castleman, F. O. Dufour, E. H. Gessner, S. Johannesson, W. S. Lohr, E. M. Noon.

JACKSON, JAMES WILLIAM, JR., Jun., Pittsburgh, Pa. (Elected June 9, 1930.) (Age 32.) Structural Designer, Aluminum Co. of America, Pittsburgh, Pa. Refers to R. B. H. Begg, F. B. Cook, Jr., M. W. Hanson, C. J. Kennedy, J. W. Rowland, A. C. Seaman, J. A. Vrydagh.

JARMAN, JUNIUS THOMAS, Jun., Galveston, Tex. (Elected June 4, 1928.) (Age 32.) With U. S. Coast & Geodetic Survey, Washington, D.C.; *S. S. Hydrographer*, on sextant work, etc. Refers to F. S. Borden, L. O. Colbert, H. A. Cotton, C. A. Egner, R. S. Patton, G. T. Rude.

JOHNSON, ARTHUR FAYETTE, Jun., Denver, Colo. (Elected Oct. 14, 1930.) (Age 32.) Asst. Engr., Grade 2, U. S. Bureau of Reclamation. Refers to E. B. Debler, H. S. Rogers, F. C. Scobey, H. M. Stafford, R. J. Tipton, S. P. Wing.

JOHNSON, RALPH PETER, Jun., Conchas Dam, N.Mex. (Elected Nov. 12, 1928.) (Age 32.) Associate Engr., U. S. Engr. Office. Refers to J. B. Alexander, H. M. Hill, H. Kramer, G. W. Phillips, H. V. Pittman.

JONES, CARL ROEMER, Jun., Corozal, Canal Zone. (Elected Nov. 18, 1935.) (Age 32.) Lieut., Corps of Engrs. Refers to L. B. Gallagher, S. C. Godfrey, M. P. O'Brien, P. S. Reinecke, G. F. Whittemore.

KARRER, WILFRED LEONARD, Jun., Boise, Idaho. (Elected Nov. 11, 1929.) With U. S. Reclamation Service, as Associate Engr., acting as Res. Engr. on raising of Arrowrock Dam. Refers to F. A. Banks, B. A. Etcheverry, B. A. Hall, R. J. Newell, R. R. Ribal.

KETTLE, KENATH AUSTIN, Jun., Charleston, W. Va. (Elected July 5, 1933.) (Age 32.) Refers to F. W. Daniels, H. S. Jacoby, J. E. Settle, R. N. Shepard, R. E. J. Summers.

MONKS, JOHN, JR., Jun., New York City. (Elected May 25, 1931.) (Age 32.) Asst. Engr. and Director, John Monks & Sons. Refers to E. D. Buel, J. V. Davies, J. Forgie, J. W. Ripley, G. E. Tilt.

PETERSON, FREDERICK GUST, Jun., Helena, Mont. (Elected March 11, 1929.) (Age 33.) Supt., Winston Bros. Co., on placer gold mining operation. Refers to F. Bass, C. C. Carey, A. S. Cutler, C. S. Heidel, L. S. Oakes.

POTTER, SEYMOUR AUSTIN, JR., Jun., Belleville, N.J. (Elected Oct. 29, 1934.) (Age 29.) Transitman, Maintenance-of-Way Dept., Erie R. R. Co. Refers to A. J. Boase, H. E. Burr, H. M. Shepard, C. H. Splitstone, C. C. Vermeule.

QUINN, FRANK TAYLOR, JR., Jun., Memphis, Tenn. (Elected Dec. 3, 1926.) (Age 32.) Asst. Works Mgr., Layne & Bowler, Inc. Refers to T. M. Hipp, E. F. Kindsvater, T. L. McManamna, W. C. McNown, F. A. Russell.

REED, GARNER WADE, Jun., Port Washington, N.Y. (Elected Oct. 30, 1933.) (Age 32.) Alignment Engr., The Port of New York Authority on second river tunnel. Refers to D. G. Baillie, Jr., B. F. Biemann, C. L. Crandall, C. S. Gleim, J. Mechanic, J. J. Nanry, J. M. C. Van Hullsteyn.

STARK, ARTHUR HENRY, Jun., Cleveland, Ohio. (Elected Nov. 14, 1927.) (Age 32.) Asst. Structural Engr., Bridge Dept., Cuyahoga County. Refers to H. T. Borton, G. B. Earnest, M. E. Friedman, O. E. Hager, L. A. Olson, F. L. Plummer, G. H. Tinker.

WITZEL, STANLEY ARTHUR, Jun., Madison, Wis. (Elected July 16, 1928.) (Age 32.) Asst. Prof. and Extension Engr., Agricultural Eng. Dept., Univ. of Wisconsin. Refers to F. M. Dawson, A. H. Fuller, D. W. Mead, J. A. Newlin, J. J. Richey, C. N. Ward.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1937 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

Construction

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; married; graduate; registered; over 20 years experience, bridges, buildings, sewage disposal, water filtration, rigid frames; 6 years in charge of design; 5 years as superintendent of construction; 3 years teaching at University of Wisconsin. Desires permanent executive position, America or British Isles. C-94.

Design

STRUCTURAL AND CIVIL ENGINEER; M. Am. Soc. C.E.; B.S.C.E., University of Michigan, 1914. Engineer of design, Pennsylvania Railroad bridge over Schuylkill River, Philadelphia. Chief draftsman, Arlington Memorial Bridge, Washington, D.C. Squad Boss, Department of City Transit, Philadelphia. Superintendent of Design, U. S. Naval Air Station, Pensacola, Fla. Air field drainage systems. Location immaterial. C-78.

HIGHWAY DESIGNER; Jun. Am. Soc. C.E.; must have a chance to earn more money than present job of squad leader and assistant office engineer yields; experienced in all types of road construction and design; capable of handling men both in the office and the field; prefers work in northeastern U. S.; 32 years old; married. C-83.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 30; college education; thoroughly experienced in design and details, bridges and buildings, also heavy construction. Capable full responsibility in office or field. Salary $225 a month with opportunity for advancement, $250 a month on temporary status. Available three weeks after acceptance. C-86.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; B.S., University of Michigan, 1921; M.S., University of Illinois, 1932. Registered in Illinios; 15 years experience in structural design of buildings and bridges, including 3 years design of continuous bridges. C-93.

Executive

CIVIL, SANITARY ENGINEER; M. Am. Soc. C.E.; 46; graduate, Massachusetts Institute of Technology; New Jersey license; married; 23 years experience technical and executive positions, governmental and private organizations on development, design, construction, operation, appraisal, rates, special studies large public water supply systems, sewerage and sewage disposal, sanitation, malaria control, flood control, hydraulic developments, highways, railroads, etc. C-98.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; B.S., professional degree; reciprocal registration; executive, 26 years active experience—planning, operating, designing, construction, valuation, reports mostly municipal, petroleum, public buildings. Own practice for long period. With PWA. Married. Excellent health. United States or foreign. Best fitted for administrative or planning tasks. Businesslike consideration of your suggestions. C-99.

EXECUTIVE ENGINEER; Assoc. M. Am. Soc. C.E.; 12 years varied experience in building construction as owners' representative, resident engineer, and designer; 4 years executive and personnel experience in Civilian Conservation Corps. Also experienced in accounting and audits. Location immaterial. Available on short notice. C-82.

CIVIL ENGINEER; M. Am. Soc. C.E.; age 55; 31 years experience administering large construction work, including tunnels, dams, heavy excavation, canals, power plants (both steam and hydroelectric). Will shortly complete main portion of one of largest projects in United States. Will be available for a new connection in the fall. C-87.

CIVIL ENGINEER; M. Am. Soc. C.E.; university education; married; 35 years experience in wide range of engineering and construction problems; 5 years as executive in successful contracting concern; 3 years service with PWA. Desires connection in engineering or construction work or in engineering sales. No choice of location. C-85.

CIVIL AND PUBLIC HEALTH ENGINEER; Assoc. M. Am. Soc. C.E.; American Society of Planning Officials; graduate of Cornell University, 1918; registered professional engineer, New York and Maine; 6 years experience, sanitary engineering; 6 years experience, highway and municipal engineering. Investigations, reports, surveys, designs, and construction; 3 years state planning executive; organization, program, and reports. Inventive. C-101.

BRIDGE ENGINEER; M. Am. Soc. C.E.; age 36; B.S. in C.E., 1924; Phi Kappa Phi honorary; registered professional engineer; good health; married; 17 years experience design and construction of roads and bridges; 6 years experience structural welding. Ability to write and talk on technical subjects. Available on very short notice. C-76.

CONTRACTOR; M. Am. Soc. C.E.; consulting engineer, designer, or sales engineer. Designer and constructor of new work, including manufacturing, commercial, industrial, or human occupancy buildings, plants, bridges, subways, and elevated railways. Owns a patented system of building construction. Interested to hear from general designers or constructors, structural steel or building material manufacturers. C-80.

Junior

ENGINEER; Jun. Am. Soc. C.E.; age 30; M.E.; 8 years drafting, mechanical and structural design; desires position teaching or with consultant engineer. C-77.

CIVIL ENGINEER; 22; B.S.E.; M.C.E.; graduate study municipal engineering problems; 2 years varied experience, surveying, topographical mapping, triangulation and general computations; 6 months field instructor in surveying; 6 months with Bureau of Water Supply, New York City. Desires position affording further training in related fields of civil engineering. Available on short notice. C-79.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; C.E., Cornell University, 1936. Experience—4 months survey work; 3 months in steel design and estimating; 1 year as 2d lieutenant, U. S. Army. Desires permanent job in design or construction, or instructorship with research opportunities. Location eastern United States, preferably New England. Available on two weeks notice. C–102.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S.C.E.; 9 months with the U. S. Army Engineers as engineering aide; experience as statistician and junior draftsman. Would like any type of civil engineering in order to gain experience. Location, United States. Available. C-81.

YOUNG ENGINEER; Jun. Am. Soc. C.E.; wants any kind of job in civil engineering field. Graduate of Cooper Union Night School, with degree of B.S. in C.E.; age 24; 2 years experience as surveyor and 2 years as topographical draftsman. Prefers location in New York City or vicinity. C-88.

CIVIL ENGINEER; student member; 21; B.S. in C.E., 1937; 3 months with road survey party; 3 months preliminary aqueduct tunnel survey, office and field; 2 months structural steel drafting and tracing. Excellent references. Now employed by state but desires immediate change with opportunity in construction field or with sales engineers. Prefers east or west coast location. C-89.

CIVIL ENGINEER; recent graduate. Prefers position as assistant to executive or engineer. Willing to start at small salary and learn. Work in or near city desirable. If offer suits, will work outside city. C-92.

GRADUATE CIVIL ENGINEER; B.S. and M.C.E.; 25; single; 9 months, supervisor of building construction; 3 months with U. S. Engineering Department as surveyman in field. Will go anywhere. Position with future preferred. C-97.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; B.S.C.E., Duke University, University of Cincinnati; special study—astronomy, water supply, sewerage disposal; 6 years varied experience in general engineering, last 4 years with Corps of Engineers, U. S. Army, in dredging and hydrographic surveying in capacity of junior engineer (Civil Service); employed; available on reasonable notice. Excellent recommendations. C-96.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; married; B.S. in C.E., Lehigh University, 1933, high honors; 3 summers, assistant in surveying school; 4 years on rolled-earth dams and concrete work (including surveying, inspection, and 2 years in charge of soils and concrete laboratory); desires position with engineering or industrial firm. C-100.

Research

CONCRETE TECHNICIAN; Assoc. M. Am. Soc. C.E.; 8 years experience as chief concrete inspector, charge of materials testing laboratory, and making materials and foundation investigations for large dams and other structures. Capable of taking charge of laboratory and inspecting project of any size. Author of a number of published articles on concrete. C-84.

Teaching

ASSISTANT PROFESSOR; Assoc. M. Am. Soc. C.E.; 36; B.S., M.S., and C.E. degrees; 7 years successful teaching experience, university and state college faculties; 7 years commercial work on railroad construction and editorial staff, engineering publication; employed at present. Desires position teaching civil engineering—especially interested in transportation, highways, traffic surveys, and structural design. C-91.

PROFESSOR OR ASSISTANT PROFESSOR, CIVIL ENGINEERING, M. Am. Soc. C.E.; graduate of Williams College (A.B. 1911, Phi Beta Kappa, Psi Upsilon) and Massachusetts Institute of Technology (B.S. 1914), with executive experience and 25 years practice in design and construction of sewer and water-supply systems and highways in United States and Europe. C-90.

INSTRUCTOR, CIVIL AND HIGHWAY ENGINEERING; Jun. Am. Soc. C.E.; 31; single; C.E. degree, Pennsylvania State College; majored in highway engineering; minored in city planning, city manager; 5 years highway engineering, surveys, design, construction, research; 2 years instructor (engineering mathematics); experienced tutor; public speaker; engineering publicity, publication work. University faculty position desired with opportunity for research study. C-95.